MAY, 1959

No. 238

ASTM Bulletin

ASTM Coast to Coast in '59

Atlantic City—June 21-26

San Francisco—Oct. 11-16

American Society for Testing Materials

RESEARCH AND STANDARDS FOR MATERIALS

ASTM BULLETIN

May 1959 — **Number 238**

Telephone: Rittenhouse 6-5315 — **Cable Address: Testing, Philadelphia**

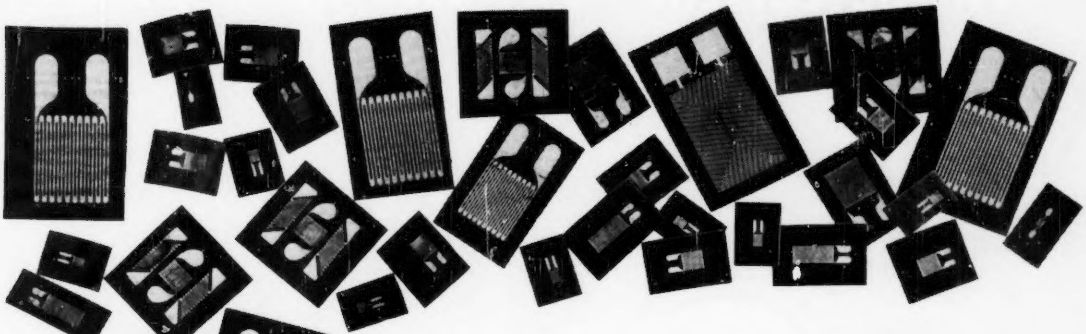
TECHNICAL PAPERS

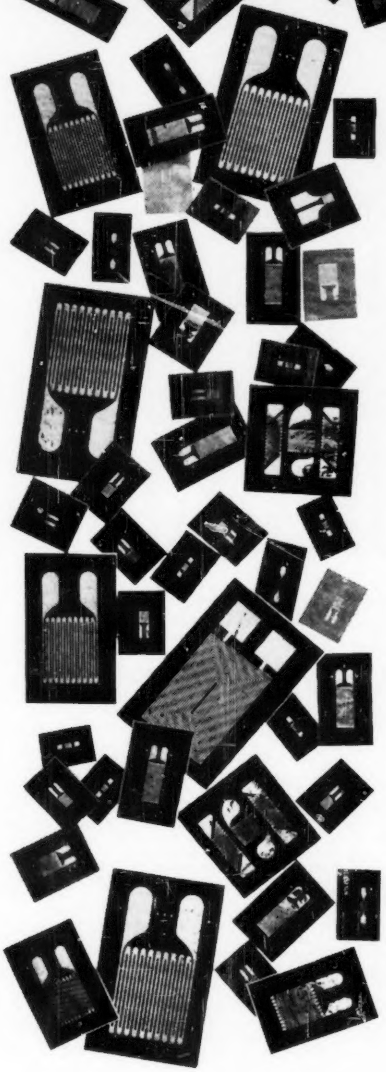
RESEARCH AND STANDARDS IN ACTION

DEPARTMENTS

ASTM Bulletin is indexed regularly by Engineering Index Inc.
ASTM Bulletin is available on microfilm from University Microfilms, Ann Arbor, Mich.

ASTM Bulletin, May 1959. Published eight times a year, January, February, April, May, July, September, October, and December, by the American Society for Testing Materials. Publication Office—20th and Northampton Sts., Easton, Pa. Editorial and advertising offices at the headquarters of the Society, 1916 Race St., Philadelphia 3, Pa. Subscriptions, United States and possessions, one year, $3.50, two years, $6.00, three years, $8.50; Canada, one year, $4.00, two years, $7.00, three years, $10.00. Other countries, one year, $4.50, two years, $8.00, three years, $11.50. Single Copies—75 cents. Number 238. Second-class mail privileges authorized at Easton, Pa.
This publication is authorized to be mailed at the special rates of postage prescribed by Section 132.123.





ASTM BULLETIN

Research and Standards for Materials

Number 238 May 1959

62nd Annual Meeting — June 21–26 Atlantic City

Summary, last-minute news, program changes

THE EDUCATION of the engineer in the materials sciences, the use of isotopes in metals analysis and testing, basic research, and an open forum on standardization of materials for nuclear reactors will be features of the 62nd Annual Meeting of ASTM at Chalfonte-Haddon Hall, Atlantic City, N. J., June 21–26, 1959.

Several sessions and symposia dealing with the engineering properties of soils, road and paving materials, bituminous mixtures, and concrete will give attention to problems important to our national highway construction program.

In addition, sessions on fatigue, effect of temperature, steel, spectroscopic excitation sources, microscopy, identification of water-formed deposits, and visual aids for standardizing and communicating product appearance will round out the program of 36 technical and report sessions.

Probably no facet of engineering education merits more discussion today than education in materials. The Symposium on **Education in Materials** scheduled for the morning and afternoon of June 22 will provide frank and friendly discussion of the viewpoints of responsible men in the fields of engineering education and representatives of industry. It is being sponsored jointly with the American Society for Engineering Education. At noon, the symposium will be supplemented by a special luncheon at which Eric A. Walker, president of The Pennsylvania State University, will be the speaker.

An informal symposium on the **use of isotopes in metals analysis and testing,** sponsored by ASTM Committee E-3 on Chemical Analysis of Metals, will present late information on that subject, Monday afternoon and evening, June 22.

The annual **President's Luncheon** will be held on Tuesday noon, June 23, at which Kenneth B. Woods will present the annual President's address. Awards, presentation of highlights from the Board of Directors' report, and recognition of 50- and 40-year members will be made at the luncheon.

On Wednesday noon, June 24, Ellis L. Armstrong, Commissioner of Public Roads, will speak at the **Highway Industry Luncheon.**

The annual **Edgar Marburg Lecture,** established by the Society to honor its first secretary, will be presented Tuesday, June 23, at 5 p m. Herman F. Mark, director, Polymer Research Institute of the Polytechnic Institute of Brooklyn, will speak on "New Polymers—New Problems."

The **Gillett Memorial Lecture,** sponsored jointly by ASTM and Battelle Memorial Inst. to honor Horace W. Gillett, first director of Battelle, will be presented by John C. Fisher, physicist, Metallurgy and Ceramics, Research Dept., General Electric Co. His subject will be "The Role of Dislocations in Plastic Deformation" (of metals).

On Wednesday evening, the **banquet and entertainment** sponsored by the Philadelphia District Council will provide relaxation for a week otherwise filled with intensive technical activity.

The Society's technical committees and their subcommittees will hold over 900 committee meetings during the week.

Open Forum on ASTM Research

On Wednesday, June 24, at 9 a m, technical committee officers and others interested in ASTM research will assemble in Haddon Hall at Atlantic City to participate in an open forum on "The Place of Research in ASTM." Promotion of knowledge of materials through research and by other means has traditionally held equal position in the Society with development of test methods and specifications. The Administrative Committee on Research, which correlates this aspect of the Society's work, is sponsoring the forum. It will provide committee officers and others an opportunity to discuss various aspects of this subject including how the technical committees and the Administrative Committee can best cooperate in the promotion and development of research.

The program will include remarks by several members of the Administrative Committee on Research, describing what the committee does, how it operates, some of its problems and in what ways it can assist the technical committees. The ASTM management's view will be covered by President Woods, other members of the ASTM Board of Directors, and Executive Secretary Painter. A most important part of the program will be participation by technical committee officers discussing the research problems of technical committees, how they feel the Research Committee can help them most, what they expect from ASTM management, and suggestions for improvement in planning and financing research and in making the results known.

All committee officers are urged to attend or be represented. This is an open forum and the public is invited.

Report of Committee D-21 Will Be Available

WHEN THE request blank for preprints of 1959 reports and papers was printed, Committee D-21 on Wax Polishes and Related Material did not plan to preprint its report. A preprinted report of the committee will now be available, however, although it does not appear on the request blank. Members wishing a copy of the report can obtain one, on request, from ASTM Headquarters.

Annual Meeting

Program Additions

In addition to the formal sessions and symposia announced in the April ASTM BULLETIN, the following committee sponsored sessions will be held:

Informal Symposium on **Isotopes in Metals Analysis and Testing,** sponsored by Committee E-3 on Chemical Analysis of Metals, will be held on Monday afternoon and evening, June 22.

Informal Session on **Electron Metallography,** sponsored by Subcommittee XI on Electron Microstructure of Metals of Committee E-4 on Metallography, will be held on Tuesday morning, June 23. The program:

Effect of Heat Treatment on a Cast Nickel Alloy—C. G. Bieber and R. F. Decker, The International Nickel Co., Inc.

Morphology of Phases in High Temperature Alloys as Revealed by the Electron Microscope—J. R. Mihalisin, The International Nickel Co., Inc.

Simplified Electron Metallography of Steels—G. E. Pellissier, Applied Research Laboratory, U. S. Steel Corp.

Techniques for Studying the Structure and Growth of Tin Oxide by Electron Microscopy—P. S. Trozzo, Applied Research Laboratory, U. S. Steel Corp.

Electron Metallography of Neutron-Irradiated Steels—R. F. McCartney, Applied Research Laboratory, U. S. Steel Corp.

Electron Microscopy of Tin Plate Alloy Layer—P. A. Stoll, Applied Research Laboratory, U. S. Steel Corp.

Electron Microscopy Observations of Dislocations in Thin Metal Foils—R. M. Fisher and A. Szirmae, Fundamental Research Laboratory, U. S. Steel Corp.

Subcommittee XI progress report on *Electron Microstructure of Precipitation-Hardenable Austenitic and Nickel-Base Alloys,* presented by R. M. Slepian, Westinghouse Electric Corp.

Instrumental Modifications for Routine Electron Diffractometry—G. R. Grieger, Jones & Laughlin Steel Corp.

Structure Analysis with Routine Electron Diffraction—G. R. Grieger, Jones & Laughlin Steel Corp.

Informal Session on **Statistical Treatment of Interlaboratory Test Results, Including a New Graphical Method,** sponsored by Committee C-1 on Cement, will be held on Thursday evening, June 25. The program:

The Cement Reference Sample Program, Introduction—R. L. Blaine

A New Graphic Method for Statistical Treatment and Evaluation of Interlaboratory Tests—W. J. Youden

Application of the Youden Technique to Cement Tests—J. R. Crandall

Discussion of the Significance of the Results of the Reference Sample Program to Cement Testing—R. L. Blaine

Application of the Graphic Method to Other Interlaboratory Testing and Specifications—W. J. Youden

Symposium on Education in Materials Top Feature

OUTSTANDING AMONG the many features of the 62nd Annual Meeting is the jointly sponsored Symposium on Education in Materials at which leaders in the fields of engineering education and industry will speak. Presidents of both the sponsoring organizations, The American Society for Engineering Education and ASTM, are on the program. In addition, the ASEE president, Dean William T. Alexander, and the ASTM president, Kenneth B. Woods, will preside at the two sessions. The program follows:

Introduction—Professor K. B. Woods, ASTM president and head, School of Civil Engineering, Purdue University

The ASTM Viewpoint on Education in Materials—Frank L. LaQue, ASTM senior vice-president, and vice-president and manager, Development and Research Div., The International Nickel Co., Inc.

The Educator's Viewpoint—William T. Alexander, ASEE president and dean of engineering, Northeastern University.

Industry's Viewpoint—Melvin F. Wood, chief engineer, E. I. du Pont de Nemours and Co., Inc.; and Glenn B. Warren, vice-president, Turbine Div., General Electric Co., and president, The American Society of Mechanical Engineers.

Education Luncheon—Speaker: Eric A. Walker, president, The Pennsylvania State University.

Nature and Properties of Materials (ASEE follow-up report on evaluation of engineering education)—Glenn Murphy, Anson Marston Distinguished Professor of Engineering and head, Department of Theoretical and Applied Mechanics, Iowa State College; vice-president, ASEE.

Solid State Physics in Relation to Materials Science, Education, and Industry—Jacob E. Goldman, manager, Physics Department, Scientific Laboratory and Engineering Research Staff, Ford Motor Co. Also Visiting Webster Professor at Massachusetts Institute of Technology.

The Viewpoint of the Civil Engineer—Henry A. Lepper, Jr., professor of civil engineering, University of Maryland.

Summary of Survey on Projected Degree in Materials Engineering—Maurice E. Shank, associate professor, mechanical engineering, Massachusetts Institute of Technology.

Intensive discussion has been under way in recent years, both in engineering education circles and in industry, on the emphasis that should be placed on materials. Both the Grinter report issued by ASEE and the Supplementary Report have pertinent sections in this area.

Basically, the purpose of these informal discussions (no preprints or prepared papers will be available in advance) is to provide an opportunity for representatives of engineering education and industry to meet in a friendly atmosphere and compare experiences and ideas.

Program Changes

Since the appearance of the Provisional Program in the April issue of the ASTM BULLETIN, it has been requested by the sponsoring committee—Committee E-12 on Appearance—that the Symposium on Visual Aids for Standardizing and Communicating Product Appearance be scheduled for presentation on Thursday afternoon, June 25 rather than on Friday morning, June 26.

Blistering Resulting From Corrosive Attack Along Weld Zone.

Second Prize, Photomicrographs, Black and White—Corrosion; Eleventh ASTM Photographic Exhibit; James H. Naser, Jessop Steel Co., Washington, Pa.

Latest Information

The complete advance program and abstracts appeared in the April issue of the Bulletin. This program is subject to change.

MONDAY, June 22	TUESDAY, June 23	WEDNESDAY, June 24	THURSDAY, June 25	FRIDAY, June 26
—MORNING—				
1 Opening Session—Symposium on Education in Materials	**8 Session on Fatigue (*Cont.*)** **9 Session on Soils**	**Administrative Committee on Research Forum** **18 Session on General Testing** **19 Symposium on Spectroscopic Excitation Sources** —11:15 a.m.— **20 Report Session** (Reports C-13, C-14, C-16, C-18, C-19, C-20, C-21, C-22, E-5, E-6)	**26 Session on Cement** **27 Session on Road and Paving Materials** —11:15 a.m.— **28 Report Session** (Reports D-7, D-10, D-12, D-13, D-14, D-15, D-22, D-23, D-26)	**34 Symposium on Microscopy (*Cont.*)**
—12:00 noon— **Education Luncheon**	—12:00 noon— **10 President's Luncheon**	—12:00 noon— **Highway Industry Luncheon**		
—AFTERNOON—				
2 Symposium on Education in Materials (*Cont.*) **3 Session on Concrete** —4:30 p.m.— **4 Report Session** (Reports B-1, B-3, B-8, B-9, F-1)	**11 Session on Steel** **12 Symposium on Methods of Test for Design of Bituminous Paving Mixtures** —4:30 p.m.— **13 Report Session** (Reports A-2, A-6, A-7, A-10, B-6, C-3, C-4, C-8, C-12)	**21 Session on General testing (*Cont.*)** **22 Symposium on Practical and Statistical Significance of Tests and Properties of Bituminous Binders** —4:00 p.m.— **23 Report Session** (Reports A-1, A-5, B-2, E-3, E-4) **24 Report Session** (Reports C-7, C-9, D-1, D-3, D-5, D-8, D-18, D-25, D-27)	**Administrative Committee on Nuclear Activities** **29 Symposium on Microscopy** **30 Symposium on Visual Aids for Standardizing and Communicating Product Appearance*** —4:30 p.m.— **31 Report Session** (Reports A-3, B-7, D-17, D-20, D-24, E-1, E-7, Jt. Comm. Leather)	—12:30 p.m.— **35 Report Session** (Reports B-4, B-5, C-1, C-11, C-15, E-2, E-12, E-13) —12:30 p.m.— **36 Report Session** (Reports D-2, D-4 D-6, D-9, D-11, D-16, E-11)
	—5:00 p.m.— **14 Marburg Lecture** **Herman F. Mark** **New Polymers—New Problems**	—4:30 p.m.— **25 Gillett Lecture** **John C. Fisher** **The Role of Dislocations in Plastic Deformation**		
—EVENING—				
5 Session on Concrete (*Cont.*) **6 Symposium on Time Rates of Loading in Soil Testing** **7 Session on Fatigue**	**15 Session on Effect of Temperature** (Report Jt. Ef. Temp.) **16 Symposium on Atterberg Limits** **17 Symposium on Methods of Test for Design of Bituminous Paving Mixtures (*Cont.*)**	**Dinner**	**32 Symposium on Microscopy (*Cont.*)** **33 Symposium on Identification of Water Formed Deposits** (Report D-19)	

* This symposium was scheduled for presentation on Friday, June 6 in the program which appeared in the April BULLETIN.

Third Pacific Area National Meeting

San Francisco — October 11-16

ANOTHER record for ASTM technical programs will be established at San Francisco, October 11 to 16, 1959, when the Society will convene for its Third Pacific Area National Meeting. Well over a year's work on the part of the General Committee on Arrangements and the Papers and Publications Committee, supported by the Board of Directors and the Headquarters Staff, will be culminated in an outstanding program of 52 technical sessions, five industry luncheons, an exhibit of instruments and apparatus, a group of educational visits to industrial laboratories and plants, and a schedule of entertainment for the ladies.

A detailed advance program is being mailed to all members and committee members in the Western Hemisphere since it is felt that these are the people most likely to be able to attend. An additional supply of advance programs is being printed for mailing on request. The July BULLETIN will include later information and changes in the provisional program as mailed this month.

Technical Program

In addition to a Forum on Nuclear Problems and a Session on Paint, the following Symposia will be held:

Masonry Materials
Ceramics in Nuclear Energy
Nondestructive Testing in the Missile Industry—2 sessions
Electrical Insulating Materials—2 sessions
Technical Development in the Handling and Utilization of Water and Industrial Waste Water—2 sessions
Spectroscopy—6 sessions: Optical Emission, X-Ray and Spectroscopy, Flame Photometry, Magnetic Resonance, Infrared Absorption, Ultraviolet Absorption.
Methods for Testing Building Constructions
Applied Radiation and Radioisotope Test Methods—2 sessions
Durability and Weathering of Structural Sandwich Constructions—2 sessions
Hydraulic Fluids—2 sessions
Materials in the Electronics Industry
Treated Wood for Marine Use
Effect of Water-Reducing and Set-Retarding Admixtures on Properties of Concrete—2 sessions
Radiation Effects and Dosimetry—3 sessions
Wood in Building Construction—2 sessions
Fatigue of Aircraft Structures—3 sessions
Reinforced Plastics—2 sessions
Thermal Ablation—2 sessions
Road and Paving Materials—2 sessions
Newer Metals—3 sessions: Properties of Refractory Metals, Nuclear and Light Metals, Processing of Newer Metals.
Bituminous Waterproofing and Roofing Materials—2 sessions
Soils for Engineering Purposes—2 sessions
Air Pollution Control—2 sessions
Post Irradiation Effects in Polymers
Standards—Are Changes in Order?

Industry Luncheons

FIVE INDUSTRY luncheons scheduled during the week will be similar to those which were so successful in Los Angeles at the Second Pacific Area National Meeting. They will provide a focal point for engineers, technicians, researchers, and management to have an opportunity to exchange greetings and ideas and to hear talks by leaders in the industries. Luncheons are scheduled in the fields of:

- **Petroleum and Chemicals**
- **Electronics**
- **Statistics**
- **Industrial Water**
- **Cement**

Apparatus Exhibit

AN ADDITIONAL attraction will be the Exhibit of Testing and Scientific Apparatus and Laboratory Supplies which is being arranged particularly for the instrument makers of the Far West, with a substantial number of apparatus and instrument makers from the East taking part.

Ladies' Entertainment

For the ladies who accompany their husbands to this meeting, an unusually fine social program has been arranged which will provide a unique opportunity to get acquainted with San Francisco and much that the area has to offer. There will be get-acquainted coffee hours, a tour of San Francisco, visits to Chinatown, a tour of the Bay area, trips on the cable cars, a night club tour, and visits to other interesting places. A fashion show will be featured on one day. In addition, information will be provided for those who like their entertainment on a do-it-yourself basis. The West Coast committee plans to underwrite a large part of the cost of the ladies' entertainment. The charge for tickets for the entire program will be about one-third of the actual cost to the committee. The ladies may expect a real treat. A schedule for the week appears on the next page.

San Francisco Skyline and Bay Bridge from Treasure Island

Plant Visits

The San Francisco Bay Area is historically the financial and trade center of the West. The nine counties bordering on San Francisco Bay support a population of some 3,500,000 and contain within their boundaries nearly 6000 industrial plants. These widely diverse industries include specialized scientific research activities and manufacturers of electronic and atomic equipment and guided missile components. Many of the plants and laboratories have generously offered to make their facilities available to ASTM visitors during the meeting. The Plant Visits Committee is arranging a list of these plants and laboratories, which will include information necessary to permit individuals and small self-organized groups to make their own arrangements for visiting, when time allows. This list will be published in the meeting program for your convenience and will also be available at the registration desk along with suitable maps or other means for location. A partial list is shown on page 10.

Because of the full technical program planned, the varied interests of members, and competing attractions, only one organized plant visit is to be arranged—a trip to the Vallecitos Laboratory of the General Electric Co. Atomic Power Equipment Dept. This Laboratory includes the General Electric-Pacific Gas and Electric Co. Atomic Power Plant, which has been granted License No. 1 by the Atomic Energy Commission.

Reservations

Members are now receiving in the mail with their advance provisional programs a registration form from the convention housing bureau. This form lists the hotels and motels which are cooperating with the Society during the meeting, and will enable members to indicate where they prefer to stay. Members are urged to return their hotel reservation forms as soon as possible.

Sheraton-Palace Hotel, Headquarters for the Third Pacific Area National Meeting

Information Desk

A SPECIAL information committee is helping with advance publicity. The committee will be happy to answer specific questions about vacation opportunities and travel from those planning to combine the meeting with their vacations; it will also have an information booth at the meeting.

Chinatown

Largest Chinese settlement outside of Asia. A living memorial to the Chinese who arrived here with the gold rush and stayed to help make San Francisco the colorful, cosmopolitan city it is today.

The Ladies' Week

Monday—A leisurely hour over coffee at the Sheraton-Palace will make new friends and renew old acquaintances. Lunch and a fashion show at noon at the St. Francis will introduce ladies to California styles.

Tuesday—Coffee 9:00 to 10:00. At 10:30 depart on 49-mile tour of San Francisco. At night, dinner at Kuo Wah's, followed by a tour of Chinatown.

Wednesday—"Tour of Three Bridges," a tour across the Oakland Bay Bridge through the residential areas of Oakland and nearby communities with a stop for lunch at one of the better restaurants, then continuing across the Richmond-San Rafael Bridge and back to the Sheraton-Palace by way of the Golden Gate Bridge. This interesting tour will take about 7 hours.

Thursday—Coffee hour 9:00 to 10:00. Luncheon at Fishermen's Wharf followed by 2-hour cruise on San Francisco Bay.

Friday—Coffee hour in the morning and a whole list of "do-it-yourself" possibilities. San Francisco is full of interesting shops and places to see.

Plant Visits Roster

Basalt Rock Co. Aggregate Expansion Plant—Rotary kiln process and expanded shale aggregate

J. H. Baxter & Co.—Wood preservation plant

Bay Area Air Pollution Control District—Specialized laboratory and library for air pollution work

Bay Area Model, Corps of Engineers—Facilities for studying tidal effects in San Francisco Bay

California Research Corp.—Petroleum research laboratory

Caterpillar Tractor Co.—Production plant manufacturing fuel injection equipment for Caterpillar engines

Friden Inc.—Manufacturers of office business machines

General Electric Co., Vallecitos Atomic Laboratory—Research laboratory for development of atomic products

International Business Machines Corp.—Manufacturing plant—data processing equipment

Owens-Corning Fiberglas Corp.—Manufacturers of glass fiber insulation and roofing products

Pacific Coast Engineering Co.—Custom designers and fabricators of reactor pressure vessels, towers, shielded containers, etc., for nuclear industry

Permanente Cement Co.—Cement plant, control laboratory and concrete laboratory

Shell Development Co.—Research in petroleum and petrochemicals

Standard Oil Company of California, Richmond Refinery—Completely integrated petroleum refinery

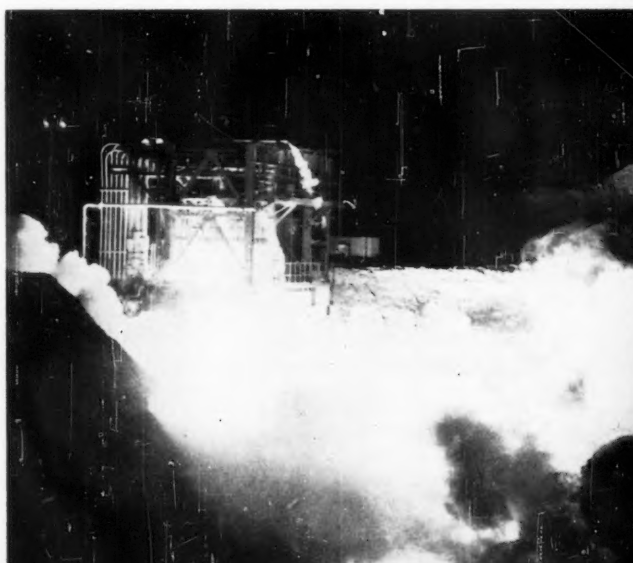
Stanford Research Inst.—Applied research in the physical sciences, electrical engineering and economics

Tracerlab, Inc.—Reactor Monitoring Center—Large radiochemical analysis facilities, instrumentation for process control of reactors, health and effluent

University of California Engineering Materials Laboratory

University of California Forest Products Laboratory—Forest products research

Western Regional Research Laboratory, Agricultural Research Service, U.S.D.A.—Research on utilization of agricultural products



Jet Engine Test Facility of Aerojet, Folsom, Calif.

GENERAL COMMITTEE ON ARRANGEMENTS

Third Pacific Area National Meeting

OFFICERS

Honorary Chairman: Theodore P. Dresser, Jr., Abbot A. Hanks, Inc.
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Vice-Chairmen: P. E. McCoy, American Bitumuls and Asphalt Co.; and M. B. Niesley, California Testing Laboratories, Inc.
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Vice-Chairmen: R. C. Vollmar, Standard Oil Co. of California; and Ernst Maag, California State Department of Public Works

Social
Chairman: R. W. Harrington, Clay Brick and Tile Assn.
Vice-Chairman: H. de Bussieres, Curtis & Tompkins Ltd.

Transportation
Chairman: C. F. Lapier, Matson Navigation Co.
Vice-Chairman: R. A. Kinzie, Jr., Pacific Cement and Aggregates, Inc.

Hotels
Chairman: W. W. Moore, Dames & Moore
Vice-Chairman: R. C. Kennedy, East Bay Municipal Utility District

Information
Chairman: C. F. Fitzwilson, Columbia-Geneva Steel Div., United States Steel Corp.
Vice-Chairman: G. F. Scherer, Rockwell Mfg. Co.

Promotion and Publicity
Chairman: T. K. Cleveland, Philadelphia Quartz Co. of California
Vice-Chairmen: R. N. Connor, Baldwin-Lima-Hamilton Corp.; and F. W. Twining, Twining Laboratories

Plant Visits
Chairman: E. V. Noe, Pacific Gas and Electric Co.
Vice-Chairman: M. C. Poulsen, Port Costa Brick Works

Industry Luncheons
Chairman: Roy Henning, Eitel-McCullough, Inc.
Vice-Chairman: Don Bowers, General Petroleum Corp.

Preventive Maintenance:—
Loosen Up!

"DOCTORS TELL US that gloomy mornings are often the result of a long series of days and nights resulting in the overuse of physical facilities and a consequent drain on the individual's pep and energy, both mental and physical.

"'Most business men who are successful have drive and initiative,' says one doctor, 'for without it they could not be successful men. Many fail to realize that this drive calls for regular periods of complete relaxation. The man who works hard five or six days a week should secure complete rest and relaxation for at least a day thereafter . . . not more hard, driving work or play. It's really odd,' he continues, 'how we realize that machinery and mechanical equipment can suffer fatigue and how we provide for its rest . . . but we completely ignore the fact that the human machine must also rest and relax.'"

ERNEST W. FAIR
"How to Avoid Mental Roadblocks"
Printer's Ink, Dec. 5, 1958

Printing Errors—Note Well

A page is out of sequence in part 3 of the 1958 Book of ASTM Standards. In the Standard Methods of Test for Alternating Current Loss and Permeability of Magnetic Materials (A 343), page 396 is not in its proper place. To correct the situation, change page numbers as follows:

Page No.	Change to
396	398
397	396
398	397

Incidentally, this test method is now being revised by Committee A-6. The revised method is expected to appear in the 1959 or 1960 Supplement to the Book of Standards.

In the paper "Analysis of Commercial Sodium Tripolyphosphate by Reverse Flow Ion Exchange Chromatography," by R. H. Kolloff, which begins on page 74 of the April 1959 ASTM BULLETIN, the captions on Figs. 4 and 6 have been interchanged. To correct the situation, interchange the captions on Figs. 4 and 6, which appear on pages 76 and 79, respectively.

No. 238 May 1959

Nineteen-Sixteen
Race Street
Philadelphia 3, Penna.

ASTM Bulletin

Joint Sponsorship is Often the Answer

WE SEEM TO notice a definite trend toward having more technical activities sponsored jointly by ASTM and other technical or professional groups having interests common to ours in a given field. Other groups of professional societies are doing the same. This would indicate that joint activities have much to commend them, and such is the case. However, when the number of sponsors gets too large the structure may get so topheavy that movement is difficult, decisions get bogged down in red tape, and then it becomes necessary to go back to a single sponsor. This was done in the case of an important project not so long ago.

Without naming the many excellent organizations that sponsor activities jointly with ASTM (most of these are listed in the Year Book), we could point to such fields as the effect of temperature on the properties of metals, filler metals (welding), cellulose and cellulose derivatives, soaps and synthetic detergents, automotive rubber, plastic pipe, leather, and many others.

In addition to these projects, some of which have been carried out jointly for many years, there are numerous others in which the sponsorship is joint in essence, though perhaps not so indicated in the Year Book. As an example we might mention the work in the refractories field where the ASTM committee gets strong support from another organization vitally concerned.

In many areas joint sponsorship can be set up with a minimum of bureaucracy, especially where there is good understanding between Headquarters organizations and a good crossover of personnel. The result is that manpower is saved, duplication of effort is avoided, and—most important—the results of the work are publicized and promoted much more widely than they would be if under one group.

In any joint activity common sense and judgment must prevail. Since no two organizations operate alike, patience is often needed. But the results justify the effort.

In a broad sense we might say that almost all activities of ASTM—the many hundreds of projects involving research and standards for materials—are jointly sponsored because every one calls for cooperation between the representatives of the consumer and those of the producer. These two groups must work together, even though at times the differences of opinion may seem great, in order for the product—notably standards—to be authoritative and useable.

The Society is grateful to the many organizations that participate with us and assist us in our technical work. We are very willing to share any acclaim that may result; but we are particularly anxious that the jobs be handled as expeditiously and efficiently as possible. In a good many areas joint sponsorship achieves this more readily than does sole responsibility.

R. J. P.

NOTICE TO MEMBERS

Advance Programs for West Coast Meeting

Advance programs for the Third Pacific Area National Meeting, to be held in San Francisco in October, will be distributed only to members located in the Western Hemisphere. Members outside this area can received programs by requesting them from Headquarters.

MATERIAL QUESTIONS

NEARLY EVERY day the mail at ASTM Headquarters includes some questions about materials, specifications, test methods or related problems. We feel that the answers, many of which are based on information given us by officers of committees in their capacity as committee officers, are of general interest. For the most part, inquiries we receive relate to the activities of the Society, either standards, research work, or publications. Often, an inquiry is such that the services of a consultant or independent testing or research laboratory is obviously required; in this event we do not hesitate to so recommend.

Corrosion Protection

We are specifying and evaluating equipment for tropospheric scatter stations. In order to evaluate the corrosion protection for aluminum and bronze wave guides and fittings, we need further information concerning the specification, application, and effectiveness of Alodine, Iridite, and other anticorrosion treatments.

● There is a military specification for chemical coatings of aluminum and aluminum alloys (MIL C-5541). W. E. Pocock has published two articles on the corrosion resistance of aluminum finishes: "Finishes for Aluminum Alloys," *Metal Progress*, Vol. 56, p. 97, Nov., 1956; and "A Survey of Chromate Metal Finishing," *Metal Finishing*, Vol. 53, p. 83, Jan., 1955. In view of the large number of finishes for aluminum, we suggest you write directly to the manufacturers of the following products: Iridite 14-2, Alodine 1200, Pylumine, Turcoat 4178, Chromicoat, Luster-On, and Cleanite 10.

There are no federal specifications that comprehensively cover coatings for magnesium. Some processes are covered in MIL-M-3171, in which reduction of tensile strength is based on salt spray testing as a means of evaluating corrosion resistance. Commercial coatings available for magnesium metals include Iridite 15 coatings of Dow Process Numbers 1, 7, 9, and 10, Dow Chemical Co.

Ultrasonic Reference Blocks

We understand your Society has developed standard reference blocks for ultrasonic testing, which may be used to check the sensitivity of ultrasonic inspection equipment. How can these be obtained?

● These reference blocks are described in the ASTM Recommended Practice for Fabricating and Checking Aluminum Alloy Ultrasonic Reference Blocks (E 127 – 58 T). The blocks may be obtained from the Ultrasonic Testing and Research Laboratory, 14710 Raymer St., Van Nuys, Calif., and are also sold by the Aluminum Company of America as their Series D ultrasonic standard reference blocks.

MATERIAL QUESTIONS

(Continued)

Nuts and Washers for High-Tensile-Strength Structural Bolts

We have recently become interested in the use of high tensile bolts and have decided to use them in three structures—Clarence River now being erected, and two others at Atiamuri and Alexandra about to be started.

Our knowledge of high tensile bolts is very limited but your specification A 325 – 58 T has been of considerable assistance. We find this specification to be perfectly clear, but we would like to ask:

1. Why are nuts of diameter 1⅛ in. and less not specified to a particular hardness? We assume that if the nut takes the proof load specified that is a sufficient test. Could it be that the nut threads are damaged slightly even if they do take this proof load apparently satisfactorily without there also being a minimum hardness specified?

2. Your requirements for hardness of washers have been raised from 65 to 70 Rockwell A (1949) to 68 to 75 Rockwell A (1953). If your minimum requirements of carburized depth (0.015 in.) remain the same we would be interested in what reasons influenced your change in hardness. Do you find in practice that it is essential to have this degree of hardness? We ask this for the reason that some are of the opinion that this degree of hardness for carburized washers is unnecessarily high.

● In answer to your first question as to why nuts 1⅛ in. and less are not specified to a hardness value, it stems from the growing tendency in this country to use finished product tests as much as possible, since they more closely correlate with the actual use of the product. The size of 1⅛ in. was chosen because the bolt and nut proof load is less than 60,000 lb, the capacity of many testing machines.

It is the desire of the committee to raise this to larger diameters (note in Section 5 that such proof tests on larger sizes are preferable), however the alternate of hardness tests or reduced specimens tests is allowable for those not having testing equipment of sufficient capacity.

A copy of the new Specification A 325 – 55 T is enclosed. Note that bolts including the 1⅛-in. size must now be tested full size, which requires a machine capable of 80,100-lb load. The next step may be to raise the nut proof load from 1⅛ in. to 1⅜ in. since this is possible on such equipment.

Regarding your second question concerning the hardness of carburized, quenched-and-tempered washers being changed from 65 to 70 Rockwell A to 68 to 75 Rockwell A, it was found that on several occasions bolt heads, when at the maximum hardness specified (32 Rockwell C), would score or dig into the washer surface, if washer hardness was on the low side. This resulted in erroneous bolt tension when determined by torque readings. Therefore, the changing to 68 to 75 Rockwell A leaves a slight spread between the hardest bolt head and the softest washer surface. Since this change was made, several years ago, there has been no further complaint.

You questioned the high value of hardness which is explained above and we would like to point out that tempering is required to obtain this hardness whether on carburized or through-hardened types which is essential to eliminate any brittle condition.

Plastics in Building

We are making a survey of information on plastics used in building construction. Do you have a bibliography of ASTM publications on this subject and could you provide information on ASTM activities?

● We do not have any check list or bibliography. However, one of the major contributions that ASTM is making in this field is to establish standard test methods and specifications which can be used to evaluate plastics for code approval. Of particular interest in this regard are test methods for strength where plastics may be used in load bearing applications, and test methods which determine permanence properties such as resistance to weathering, to chemicals, etc.

Plastic pipe is being increasingly used in buildings and in this connection there are several ASTM methods of test, in particular: Method of Test for Time-to-Failure of Plastic Pipe Under Long-Term Hydrostatic Pressure (D 1598 – 58 T), and Method of Test for Short-Time Rupture Strength of Thermoplastic Pipe, Tubing & Fittings (D 1599 – 58 T). These tests can be used as a basis for estimating the suitability of pipe for carrying fluids under pressure.

In the past year or two several standards relating to reinforced plastics have become available and since these are coming into fairly wide use for patio covers and other glazing applications, the following methods should be of special interest: Method of Test for Transverse Strength of Corrugated Reinforced Plastic Panels (D 1502 – 57 T) and Method of Test for Bearing Load of Corrugated Plastic Panels (D 1602 – 58 T).

Certain other activities in ASTM apply to plastics in building. As you probably know there is a very active Committee C-16 on Thermal Insulating Materials. Also, Committee C-19 on Structural Sandwich Constructions is concerned with many materials, including plastics, which are used in the sandwich form. There are a number of test methods developed by this committee to determine the properties of this type construction. Committee E-6 on Methods of Testing Building Construction has developed standard test methods for panels and their constructions.

Committee E-5 on Fire Tests of Materials and Constructions has developed the so-called tunnel test (E 84) for determining flammability of materials. Several papers published recently discuss surface flame spread tests with particular application to plastics. A paper on this subject appeared in the 1956 *Proceedings*, beginning on page 1437. A method for surface flammability is described in the 1958 compilation of ASTM Standards on Plastics, page 1055.

Special National Technical Meetings Authorized

THERE IS just so much business you can pack into one week. For some time now the handwriting on the wall has indicated that we are approaching the limit in our Annual Meeting week—a staggering number of technical sessions, symposia, and technical committee meetings are now crammed into those few days. Even with the Spring Committee Week to relieve some of the congestion, indications are that the growth of the Society in the next 5 or 10 years will cause the Annual Meeting to burst at the seams. To relieve the congestion, and also to give wider circulation to the ideas discussed at the technical sessions, our Board of Directors has authorized the holding of "Special National Technical Meetings" throughout the year.

It is expected that such meetings would include one or more technical sessions or symposia as well as meetings of one or more of our technical committees. It may be that a District might wish to hold such a meeting and would invite certain committees to meet at that time. Our Rocky Mountain District, for example, held a two-session symposium in Salt Lake City, March 6, on the subject "Explosives and Their Relationship to Materials." Several outstanding authorities participated. Attendance was nationwide. This meeting, had it been an authorized National Technical Meeting, would have received the wider publicity and recognition due it.

Our Committee F-1 on Materials for Electron Tubes and Semiconductor Devices held in Philadelphia last fall a two-day, four-session Symposium on Cleaning Electronic Device Components and Materials. This meeting, also, could very easily have been a Special National Technical Meeting.

There is a growing tendency for groups of our committees to meet together, or in the same week, for example C-1 (Cement) and C-9 (Concrete); D-9 (Electrical Insulation) and D-20 (Plastics); D-2 (Petroleum) and D-16 (Hydrocarbons). These group meetings afford a natural opportunity for National Technical Meetings, through the addition of technical sessions, developed in the committees themselves, or possibly in the Administrative Committee on Papers and Publications.

Special National Technical Meetings will develop at the grassroots. There will be no stimulation of such meetings either from Headquarters or from Society officers. Should the organizing group wish it, of course, Staff help will be available for such matters as hotel accommodations, and publicity.

NEW ASTM PUBLICATIONS

Symposium on Bulk Sampling

THE MAIN purpose of this symposium is to provide further understanding of sampling for those persons charged with the responsibility of preparing specifications involving sampling. A second objective is to give persons, faced with the interpretation of specifications and results based on sampling, a few rules to help prevent gross mistakes in making decisions.

All too often the purposes and the consequences of a recommended sampling procedure are not clearly thought out, and for this reason the results may be misinterpreted in terms of the specifications. There is clearly a need for better planning in the preliminary stages of the materials testing program before the specifications are set. This symposium attempts to help the reader to fill that need. Papers included are:

Studies in Ore Car and Abrasive Grain Sampling Variation—R. S. Bingham, Jr., J. L. Gioele, and V. B. Shelburne

Measurement Error Considerations in Bulk Sampling—With Special Reference to the Sampling of Fertilizer—A. J. Duncan

The Effect of Increment Weight on Sampling Accuracy—W. M. Bertholf

Physical Interpretation of Coal Sampling Variances with Application to Sampling Reduction—B. A. Landry

Special Technical Publication No. 242

Elevated Temperature Properties of Cast Iron

THIS PUBLICATION is the result of a research project, begun in 1954, sponsored by the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals. In this study, the properties of six commercial low-alloy gray irons and one unalloyed ferritic nodular iron were evaluated at 800 F and 1000 F by means of metallographic examination, tension, creep-rupture, thermal shock, and growth tests. Both as-cast and annealed structures were investigated.

The objective of this research was to determine the suitability of cast-iron alloys for load-carrying applications in the temperature range of 700 to 1000 F. Results of tests are clearly presented and illustrated with graphs, tables, and photomicrographs.

The work was done at the Southern Research Inst., Birmingham, Ala., under the direction of J. R. Kattus, head, Metallurgy Division. This report was prepared by J. R. Kattus and Bryan McPherson of Southern Research Institute and is available either from ASTM Headquarters or the ASME at 29 W. 39th St., New York 18, N. Y.

STP 248; 96 pages, paper cover, price \$4.25, to ASTM and ASME members \$3.40.

Symposium on Materials Research Frontiers

THE NEEDS of a rapidly changing technological era are crowding hard upon the physical and chemical limitations set by available engineering materials. In every area of advancement—new construction designs; faster, lighter, more powerful engines and machines; higher temperature processes and reactions; nuclear science and engineering; and aircraft and missile development—the demand is for ever higher performance from the materials involved. Some of the country's most competent talent is engaged in the search for better fundamental understanding of the properties of matter and its translation into improved materials.

In this symposium, outstanding leaders in materials research discuss accomplishments in their respective fields that are helping to meet pressing challenges of the present and will assist us to prepare for the unfolding future. Papers included are:

Tailoring the Properties of Materials—E. P. Stevenson

Materials in the Nuclear Age—J. J. Antal

Modern Liquid Fuels—A. L. Lyman

New Advances in Physical Metallurgy—W. R. Hibbard

Recent Developments in Glass Research—W. W. Shaver

STP 243; 52 pages, hard cover, price \$2.00, to members \$1.60.

Symposium on Instrumentation in Atmospheric Analysis

BECAUSE OF the high variability of air pollutants in composition and concentration in any one place, periodic analysis is not very significant. Indeed, it can present quite a distorted picture. On the other hand, continuous analysis of different pollutants at various locations can provide accurate data useful in appraising pollution hazards and in indicating effective control measures.

This symposium presents a sampling of results from the extensive efforts in recent years to development instruments capable of continuous analysis and recording of air pollutants. How effective are filters for quantitative removal of particles for analysis? What is the lower limit of particle size that can now be detected and measured by light-scattering instrumentation? What are the relative merits of various spectrographic instruments and what progress has been made in continuous analysis of fluorides in the air? These questions and more are answered in this publication. It should be useful not only to those who are concerned with measurement and control of atmospheric pollutants but also to air conditioning engineers and others concerned with instrumentation generally. Papers included are:

Filtration Methods for Evaluation of Aerosol Contaminants—M. Katz and H. P. Sanderson

Light Scattering Instrumentation for Particle Size Distribution Measurements—C. T. O'Konski, M. D. Bitron, and W. I. Higuchi

Relative Merits of Gas Chromatography, Colorimetry, and Spectrometry for Air Pollution Measurements—L. H. Rogers

The SRI Fluoride Recorder—M. D. Thomas, G. A. St. John, and S. W. Chaikin

Special Technical Publication No. 250

Steel Piping Materials

Compilation of Standards, A-1

THIS COMPILATION of ASTM Standards on Steel Piping Materials contains all the specifications for carbon-steel and alloy-steel pipe and tubing issued by the Society.

The specifications in this compilation cover: pipe used to convey liquids, vapors, and gases at normal and elevated temperatures; still tubes for refinery service; heat exchanger and condenser tubes; and boiler and superheater tubes. To make the volume more complete specifications are also included for castings, forgings, weldings, bolts, and nuts used in pipe and related installations.

There are 71 standards in the book. Of these 49 have recently been revised or have had their status changed within the year. This compilation replaces the edition published in March, 1958. Many of the specifications in this compilation are incorporated in the ASME Boiler and Pressure Vessel Construction Code.

ASTM Standards on Steel Piping Materials, 524 pages, paper cover, price \$6.00, to members \$4.80.

Actions on Standards

THE ADMINISTRATIVE COMMITTEE ON STANDARDS is empowered to pass on proposed new tentatives and revisions of existing tentatives, and tentative revisions of standards offered between Annual Meetings of the Society. On the dates indicated the Standards Committee took the following actions. Anyone interested in securing copies of the standards should write to Headquarters regarding their availability.

Cast Iron

Standard Specifications for Cast Iron Culvert Pipe (A 142–38) (Accepted April 13, 1959)

Revision and Reversion to Tentative.—A new Section 3 on Pressure Pipe Alternate has been added which stipulates that cast iron pipe manufactured in accordance with the Specification for Cast Iron Pressure Pipe (A 377) may be furnished as alternate as long as the nominal shell thickness is not less than nominal thicknesses as shown in Table I of Specifications A 142, and the pipe has a bursting tensile strength of 1800 psi and a modulus of rupture of 40,000 psi.

Metallic Materials for Electrical Heating, Electrical Resistance and Electrical Contacts

Tentative Method of Test for Surety of Make of Electrical Contact Materials (B 340–59 T) (Accepted March 25, 1959)

New Tentative.—The materials used for electrical contacts vary in their ability reliably to make a circuit when subjected to adverse environmental conditions. This method can be used by suppliers and users to compare the performance of various contact materials. Two procedures are covered—the determination of the voltage necessary to produce circuit continuity through electrical contacts when a specified force is used, and the measurement of the resulting contact resistance with a specified current.

Thermal Insulating Materials

Tentative Specification for Amosite Asbestos Thermal Insulation for Pipes (C 391–59 T) (Accepted April 13, 1959)

New Tentative.—This specification covers the composition, dimensions, and physical properties of amosite asbestos thermal insulation for pipes intended for use on surfaces operating at temperatures up to 1200 F. Amosite asbestos is a silicate or iron in a fibrous form which can be designated by formula as $(FeMg)SiO_3$.

Glass and Glass Products

Standard Method of Polariscopic Examination of Glass Containers (C 148–50) (Accepted March 15, 1959)

Revision and Reversion to Tentative.—The current method involves comparison of the annealing strain in a container with that in standard disks through the use of a polariscope. An alternate method has been added which does not involve the use of the disks since the original supply of the disks is now depleted and the cost of producing further sets is prohibitive. A note has been added to Section 1 calling attention to the fact that interpretation of the significance of the results obtained with the method involves considerations which are not stated or discussed in the method itself. Editorial changes have also been made.

Standard Method of Internal Pressure Test on Glass Containers (C 147–50) (Accepted March 25, 1959)

Revision and Reversion to Tentative.—The minimum duration of the test has been changed from 15 sec to 3 sec, the maximum remaining at 60 sec. The purpose is to make the test less time-consuming, especially when the test is carried step-wise to destruction of the bottle.

Tentative Methods for Sieve Analysis of Glass Making Raw Materials (C 429–59 T) (Accepted March 25, 1959)

New Tentative.—These methods provide standard practices of sieve analysis for estimating the particle size distribution of common glass making raw materials such as sand, soda-ash, limestone, alkali-alumina silicates, and other granular materials used in glass batch.

Wood

Tentative Specifications for Chromated Copper Arsenate (D 1625–59 T) (Accepted March 25, 1959)

Tentative Specifications for Acid Copper Chromate (D 1624–59 T) (Accepted March 25, 1959)

Tentative Methods for Chemical Analysis of Chromated Copper Arsenate (D 1628–59 T) (Accepted March 25, 1959)

Tentative Methods for Chemical Analysis of Acid Copper Chromate (D 1627–59 T) (Accepted March 25, 1959)

New Tentatives.—Specifications cover chromated copper arsenate and acid copper chromate, either in the solid form or in solution, for use in the preservative treatment of wood. Methods for chemical analysis have been provided.

Shipping Containers

Tentative Method of Test for Dynamic Properties of Package Cushioning Materials (D 1596–59 T) (Accepted March 26, 1959)

New Tentative.—This test was developed to provide the shipping container industry with a standard method of dynamically testing materials exhibiting a high degree of compressibility and recovery in bulk, sheet, or molded forms used for cushioning packaged articles.

Tentative Definitions of Terms Relating to Shipping Containers (D 996–56 T) (Accepted March 25, 1959)

Revision.—As part of a continuing program to standardize the terms used in the shipping container field, definitions have been added for 21 additional terms.

Rubber and Rubber-Like Materials

Tentative Method of Test for Abrasion Resistance of Rubber Soles and Heels (D 1630–59 T) (Accepted March 25, 1959)

New Tentative.—This method is intended for use in determining the resistance to abrasion of vulcanized elastomer compounds used in the soles and heels of footwear. It is not recommended for materials thinner than 0.1 in. The method is a revision of Procedure B of the Methods of Test for Abrasion Resistance of Rubber Compounds (D 394–47).

Tentative Methods for Chemical Analysis of Rubber Products (D 297–55 T) (Accepted March 25, 1959)

Revision.—Changes relate to Section 54 on Reagents; Section 56 covering Copper Method A, Photometric Procedure from Alkaline Solution (Referee Method); and Section 59 covering Manganese Method A, Photometric Procedure (Referee Method) in order to bring Methods D 297 into line with ISO Rubber Method 383.

Tentative Methods of Testing Hard Rubber Products (D 530–57 T) (Accepted March 25, 1959)

Revision.—A water absorption test was added comprising Sections 43 to 47.

Tentative Methods of Test for Indentation of Rubber by Means of a Durometer (D 676–58 T) (Accepted March 25, 1959)

Revision.—A conversion chart was added in order to clarify Note 1 in Section 2(*c*) on Indicating Device.

Tentative Recommended Practice for Description of Types of Styrene-Butadiene Rubbers (SBR) (D 1419–58 T) (Accepted March 25, 1959)

Revision.—Two new SBR rubbers have been added and assigned the numbers 1506 and 1804.

Tentative Recommended Practice for Description of Types of Styrene-Butadiene Rubber (SBR) and Butadiene Rubber (BR) Latices (D 1420–58 T) (Accepted March 25, 1959)

Revision.—Grade number 2109 has been assigned to a new SRB latex.

Industrial Aromatic Hydrocarbons

Tentative Method of Test for Water in Phenol and Related Materials by the Iodine Reagent Method (D 1631–59 T) (Accepted March 25, 1959)

Actions on Standards

New Tentative.—This method is intended for the determination of water in phenol and related materials such as cresols, xylenols, naphthalene, pyridine and quinoline. The method is particularly adapted to determining small amounts of water in hygroscopic materials but it is generally applicable to a variety of materials varying in water content from 100 parts per million to aqueous solutions containing a relatively high percentage of water. The method is not applicable in the presence of mercaptans, peroxides, or appreciable quantities of aldehydes or amines.

Soils for Engineering Purposes

Tentative Method of Test for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory (D 1632-59 T) (Accepted March 25, 1959)

Tentative Method of Test for Compressive Strength of Molded Soil-Cement Cylinders (D 1633-59T) (Accepted March 25, 1959)

Tentative Method of Test for Compressive Strength of Soil-Cement Using Portions of Beams Broken in Flexure (Modified Cube Method) (D 1634-59 T) (Accepted March 25, 1959)

Tentative Method of Test for Flexural Strength of Soil-Cement Using Simple Beam With Third-Point Loading (D 1635-59 T) (Accepted March 25, 1959)

New Tentatives.—With the increased use of compacted soil-cement as a construction material, many test procedures have been developed to design strength properties peculiar to the material. These methods will aid engineers to use and design soil-cement, to take advantage of its structural properties, and provide industry with standards for control.

Plastics

Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon Arc Type) for Exposure of Plastics (D 1499-59 T) (Accepted March 25, 1959)

New Tentative.—This recommended practice covers specific variations in test conditions which shall be applicable when the Tentative Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon Arc Type) for Artificial Weathering Test (E 42-55 T) is employed for the exposure of plastics. Also covered are the preparation of test specimens, the test conditions best suited for plastics, and the evaluation of results.

Tentative Specifications for Extruded Acrylic Plastic Sheet (D 1547-59 T) (Accepted March 25, 1959)

New Tentative.—Two grades of extruded acrylic sheet are covered—Grades 6 and 8 manufactured from the same grade methacrylate molding compounds meeting the ASTM Specification for Methacrylate Molding and Extrusion Compounds (D 788). This specification is of particular interest to those concerned with outdoor and office lighting since the material is widely used for diffusing light in indoor and outdoor fixtures.

Method of Test for Compressive Strength of Rigid Cellular Materials (D 1621-59 T)

New Tentative.—This method provides information regarding the behavior of rigid cellular materials, particularly expanded plastics, under compressive loads. Deformation data can be obtained, and from a complete load-deformation curve it is possible to compute the compressive stress at any load and to compute the effective modulus of elasticity.

Tentative Method of Test for Apparent Density of Rigid Cellular Materials (D 1622-59 T) (Accepted March 25, 1959)

New Tentative.—Density is an important property of rigid cellular materials for specification purposes and is often a critical factor in the application of the material.

Tentative Method of Test for Tensile Properties of Rigid Cellular Materials (D 1623-59 T) (Accepted March 25, 1959)

New Tentative.—These methods are intended for use in determining the tensile properties of rigid cellular materials in the form of test specimens of standard shape under defined conditions of temperature, humidity, and testing machine speed. Two types of tension tests are described. Method A may be preferred in those cases where enough sample exists to form the necessary specimen, while Method B may be used where only smaller specimens are available, as in sandwich panels.

Tentative Specification for Allyl Molding Compounds (D 1636-59 T) (Accepted March 25, 1959)

New Tentative.—Thermosetting molding compounds consisting of allyl resins that have been combined with fillers, pigments, and other agents are covered by this specification. Three types of allyl molding compounds are covered—the general purpose powder of pellets with mineral and/or glass fillers, the general purpose powder or pellets with organic fiber fillers, and high strength materials with glass fiber fillers.

Tentative Method of Test for Tensile Heat Distortion Temperature of Plastic Sheeting (D 1637-59 T) (Accepted March 25, 1959)

New Tentative.—This method covers a procedure for determining the temperature at which thermoplastic sheeting begins to deform (either stretch or shrink) appreciably under a small specified load applied in tension. Because of difficulties of mounting specimens and changes in the rate of heat transfer, this method is restricted to sheets and films from 0.001 to 0.060 in. thick. The method is applicable only to materials that have a modulus greater than 10,000 psi at 23 C (70 F).

Tentative Specification for Cast Methacrylate Plastic Sheets, Rods, Tubes, and Shapes (D 702-58 T) (Accepted March 25, 1959)

Revision.—New cast methacrylate sheets which have not been preshrunk have become commercially available and are being used in aircraft applications. These sheets have a higher initial shrinkage value than the materials presently covered by the specification, and the specification was revised to cover these newer products.

Tentative Specification for Nylon Injection Molding and Extrusion Materials (D 789-53 T) (Accepted March 25, 1959)

Revision.—The specification has been expanded to cover six types of nylon materials suitable for injection molding and/or extrusion. Some of the compositions are also suitable for compression molding and application from solution.

Tentative Method of Test for Flexural Properties of Plastics (D 790-58 T) (Accepted March 25, 1959)

Revision.—Paragraph (1) of Section 5(*a*) has been clarified as regards specimen sizes.

Tentative Definitions of Terms Relating to Plastics (D 883-58 T) (Accepted March 25, 1959)

Revision.—Definitions have been added for urethane plastics, forming, and thermoforming.

Tentative Specifications for Polyester Molding Compounds (D 1201-58 T) (Accepted March 25, 1959)

Revision.—A new type-6 polyester molding compound has been added which is a high-impact, glass-fiber-filled material in putty form.

Quality Control

Tentative Recommended Practice for the Acceptance of Evidence Based on the Results of Probability Sampling (E 141-59 T) (Accepted March 25, 1959)

New Tentative.—In view of the increasing use of sampling in industry, there is need for a rule by which to accept or to reject evidence based on samples. The data may come from tests of samples of materials or other sources pertinent to the decision to be made.

Materials for Electron Tubes and Semiconductor Devices

Tentative Specification for Round Wire for Use as Grid Siderods in Electron Tubes (F 9-59 T) (Accepted April 13, 1959)

New Tentative.—This specification covers round wire in three classes from 0.010 to 0.075 in. in diameter for use as grid siderods in electron tubes and in a form applicable to direct feeding into equipment employed in grid fabrication. The specification fills an important need in the industry for close control of dimensions of siderod wire so that accurate fit may be obtained in mica spacers. The performance of the tube depends to a great degree on the location of the grid in relation to the other electrodes. Control of electrode spacing in modern tubes is extremely critical and noise figure and other electrical characteristics are affected.

ASTM Standards Approved as *American Standard* by American Standards Association

TEXTILES

(Approved March 2, 1959)

Methods of Testing and Tolerances for Cotton Yarns (ASTM D 180–57 T; ASA L14.13-1959)

Methods of Testing Sewing Threads (ASTM D 204–57 T; ASA L14.14-1959)

Methods of Testing Felt (ASTM D 461–57; ASA L14.52-1959)

Methods of Testing Man-Made Staple Fibers (ASTM D 540–57 T; ASA L14.33-1959)

Methods of Testing Spun and Filament Yarns Made Wholly or in Part of Man-Made Organic Base Fibers (ASTM D 1380–57 T; ASA L14.90-1959)

SIEVES FOR TESTING PURPOSES

(Approved March 30, 1959)

Specifications for Sieves for Testing Purposes (Wire Cloth Sieves, Round-Hole and Square-Hole Screens or Sieves) (ASTM E 11–58 T; ASA Z23.1-1959)

New Nickel Oxide Standard

For Spectrographic and Chemical Analysis

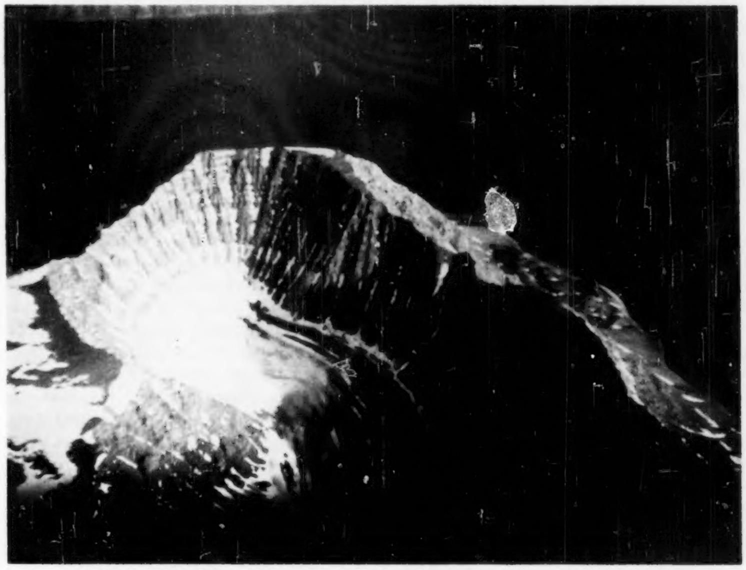
A NEW STANDARD sample of nickel oxide powder is now available from the National Bureau of Standards. Analyzed and certified for nine minor and trace elements, the standard is intended for checking and calibrating spectrochemical and chemical methods used in the analysis of high-purity nickel, particularly electronic-grade and electrolytic nickel.

Nickel is available in many forms and, because of its hardness and resistance to corrosion and heat, has many electronic and electrical applications. The thermionic properties of nickel are also of special interest to the electronics industry. Since these and other properties depend on chemical composition, the new standard should be of value in developing high-purity nickel materials.

The new standard, NBS 673, supplements the nickel oxide standard samples NBS 671 and 672, issued in 1957. All three samples have been prepared cooperatively by the Bureau and a task group of ASTM Committee F-1 on Materials for Electron Tubes and Semiconductor Devices. Similar to the other two, the new standard is designed primarily for application in the spectrographic analysis of nickel and nickel alloys by ASTM Methods for Emission Spectrochemical Analysis, E 129 – 57 T. The three standards are also equally suited for chemical analysis.

The analytical results of nine cooperating laboratories, representing the Bureau and producers and consumers of nickel, are given on a provisional certificate of analyses. The standard has been analyzed and certified for cobalt, copper, iron, magnesium, manganese, silicon, titanium, aluminum, and chromium.

The nickel oxide standard is packaged in bottles containing 25 g and is available from the Standard Sample Clerk, National Bureau of Standards, Washington 25, D. C. The fee is $8.00 per sample. A provisional certificate of analysis accompanying the standard sample lists the analytical results of the cooperating laboratories.



Air View of Arctic Cirque

This cirque was photographed by ASTM President K. B. Woods at about midnight, north of the Arctic Circle, along the west coast of Greenland, in the summer of 1956. A 36 by 24-in. color print was presented to the Headquarters Staff, Christmas, 1958, by President and Mrs. Woods. After a little research, we found that a cirque is an amphitheater-shaped depression formed in the higher parts of mountain ranges. It is the result of glacial action, or the disruption of rock by frost action around a snow field. The one in this very striking photograph was caused by a glacier.

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

Date	Group	Place
June 2	Conference on Metallic Ores	Philadelphia, Pa. (ASTM Headquarters)
June 18–19	Committee F-1 on Materials for Electron Tubes and Semiconductor Devices	Boston, Mass. (Statler-Hilton Hotel)
June 21–26	**Annual Meeting**	Atlantic City, N. J. (Chalfonte-Haddon Hall)
Sept. 14	Committee D-22 on Atmospheric Sampling and Analysis	Philadelphia, Pa. (ASTM Headquarters)
Sept. 22–24	Committee B-5 on Copper and Copper Alloys, Cast and Wrought	Washington, D. C. (Sheraton Park Hotel)
Sept. 29–30	Committee C-22 on Porcelain Enamels	Columbus, Ohio
Oct. 7–8	Committee C-8 on Refractories	Bedford, Pa.
Oct. 11–16	**Third Pacific Area National Meeting**	San Francisco, Calif (Sheraton Palace Hotel)
Oct. 13–16	Committee D-13 on Textile Materials	New York, N. Y. (Sheraton-McAlpin Hotel)
Oct. 15–16	Committee C-3 on Chemical Resistant Mortars	Glens Falls, N. Y. (Queensbury Hotel)

Committee Work and Fundamental Research

By Jay C. Harris

This address was presented by Mr. Harris at the March 10 meeting of Committee D-12 on Soaps and Other Detergents. At the meeting, Mr. Harris was presented the committee's annual award for outstanding achievement in the field of soap and detergent technology. Chairman of Committee D-12 since 1950, Mr. Harris has worked in the development of synthetic detergents since their inception in this country. He is presently director, Application Research Dept., Monsanto Chemical Co., Dayton, Ohio.

One of the most frequent questions asked of those who seem to have a variety of interests and become recognized for some one of them is, "How do you find time to do it?" When some of these activities involve committee work, perhaps the most effective answer is that work on problems immediately or potentially useful to your company and of personal interest to you can easily be justified. To be able to satisfy two programs with a single course of action always seems creditable.

If you are personally unable to serve as chairman of a newly established group, it frequently becomes possible to stimulate another capable and interested person to carry on the work. A chairman must guide the course of the work, inspire continued interest, and give his committee people something to "shoot at." Those who take part in a program get much more out of it than an "observer."

The work of Committee D-12 on Soaps and Other Detergents has followed several trends. When the committee was formed, soaps were the only real detergents, and the course followed was to develop analytical procedures so that satisfactory specifications could be written. Synthetic detergents were then a small shadow on the horizon. With the advent of surfactants and syndets in volume, analytical procedures lagged, and performance testing (for comparative purposes) took the ascendency. The multiple difficulties inherent in performance testing and acceptance has slowed this progress, and the picture has turned again to analytical procedures for surfactants now that the plethora of products has been narrowed to outstanding survivors.

A word about performance testing is justified, for much good work has been done in this field. These methods frequently have been more or less patterned after commercial processes, with at least all their inherent parameters. Fundamental differences in wash test methods have not been resolved, though much effective research effort has been published. The inherent difficulty in even a rather narrow cleaning operation is the complexity and variability of both substrates and soils. Choice of generally acceptable variables becomes extremely difficult. No "standard" soil has appeared, though in some cases "standardized" soils have been used successfully.

A more basic approach to the detergency problem is apparent in the large volume of high-quality published research work. My own efforts in this fundamental approach were initiated in a very small way in 1947 after Corrin, Klevens, and Harkins (in 1946) published what might flippantly be called the "poor man's" methods for measuring critical micelle concentration. The period until 1956 precluded pursuance of fundamental work but was a fairly productive one of practical performance application, covering all aspects of detergency evaluation, formulation, and application, terminated by transfer of these duties to an operating division. After more than 20 years in development of application and evaluation procedures, there comes a time when continued polishing of a set of methods gives only minor return for the effort. Since fundamental measurements had represented only a very minor effort, and because major breakthroughs can come from fundamental studies, a program aimed at clarifying the mechanism of soil removal by surfactants and builders was initiated.

Some of you may have noted publication of the several surveys concerned with factors in the detergent operation. These are a portion of what will be a complete series assaying the published research in this broad field. As published, these are largely compendia of the pertinent known information with no real attempt at critical evaluation. A critical evaluation of the data is required to direct research effort.

Preston's discerning work demonstrating the qualitative connection between critical micelle concentration (cmc) and detergency, and Goette's summary of the effects of this and other variables influenced our approach. Our initial effort in this field began with a study of the outstanding characteristic of surfactant solutions—that of the ability of molecules to aggregate into regular associations called micelles. At this point, two approaches were followed: that of studying micellar formation and factors affecting it; and that of studying soil removal employing a radiotagged soil, applying to it information obtained from the first phase.

Our first effort in micelle research required comparison of methods of measurement; the initial publication on this research (December, 1958) pointed out pitfalls and variabilities of the spectral dye procedure when used with commercial surfactants. Since many methods of estimation are based on the ionic character of the molecule, one generally applicable including nonionics was required for direct comparison purposes. The one selected involved solubilization of a water-insoluble dye as a measure of micellar formation.

We were once asked by a consultant why we were interested in micelle measurement. Certainly from the academic viewpoint such measurement would be concerned with the apparent molecular weight, size, shape, and other physicochemical aspects of these aggregates. Our viewpoint is that cmc is closely related to the surface active function of

the surfactant molecule, and in addition to finding out how it is related to soil removal, we want to correlate it with other surfactant properties not already elucidated by others. Applications of this measurement which might sharpen already available and proved evaluation procedures or provide bases for still other methods of evaluation or prediction are certainly not excluded from our agenda.

Critical micelle concentration values have provided the only reasonable explanation for the fact that nonionics of selected characteristics can be used in such relatively small proportions as the active constituent in detergent compositions. The relationship is not as yet a clear-cut one, reducible to equation form, but it offers a base for future work. Using cmc values, it is possible to predict the effective or equivalent carbon chain lengths of surfactant compounds. We confirm the findings of others that cmc formation in surfactant-builder systems is largely dependent upon the builder cation concentration. Hard-water tests have demonstrated that effect on cmc is not only controlled by the cation concentration or type of builder, but by the ability of builders to soften water (or sequester the Ca and Mg ions causing hard-water difficulties) and is also dependent upon the builder anion type and concentration. Optimum formulation compositions may be predicted from such data. As Preston pointed out, cmc is related to detergency, and we are currently attempting to form a quantitative relationship. Cmc as a function of temperature for a variety of surfactants has been determined, and this may change some previous concepts of this relationship.

The other approach, using a radiotagged soil, has resulted in demonstration of the mechanism of removing oily soil from glass. This work is being extended to a variety of surfactant systems, soils, and substrates. Here, again, cmc is related to detergency and a quantitative relationship is sought.

The insight and clarity of the thinking of Langmuir and Harkins is truly amazing. Over 40 years ago, Langmuir had conceived of adsorption as occurring at "elementary spaces," and this concept continues repeatedly to be affirmed. Our own work on oily soil removal indicates this type of adsorption for glass surfaces. Adsorption, without which detergency could not occur, appears to be a fruitful area for investigation. The rate of adsorption at soil/substrate/detergent-solution interfaces is an area we are already investigating. Desorption of surfactant which occurs during rinsing is another facet of this picture. Some work, notably that of Kling and his co-workers, has been concerned with the energetics (kinetic and thermodynamic) of the washing system, and this is another area meriting very serious attention.

These are the areas in which we, as well as others, are already working, or in which we intend to work. Thus far, we have found applications for fundamental measurements which already existed but which had not previously been applied; it is expected that others may be developed. Certainly the goal of elucidating the mechanism of detergency is an ambitious and long-range one, and only the surface has been scratched.

At this stage, it is difficult to predict whether information from the fundamental approach will be directly applicable to D-12 committee work. Considerable study of such findings and their application to either narrow or broad segments of our problems should be considered; fundamental measurements have much to recommend them.

It would be a serious oversight not to mention that only by being blessed with highly cooperative associates could this research and committee work be accomplished. The enthusiastic and well-planned activities of my several associates at Dayton, particularly those of Richard M. Anderson and Martin E. Ginn, have been largely responsible for the quality and progress of that research. Concerning D-12 committee work, so many have contributed to what success we have had, that the entire committee roster might well be included.

Know Your Committee Officers

To better acquaint Bulletin readers with the men who direct the indispensable work of the ASTM technical committees.

Committee D-27 on Electrical Insulating Liquids and Gases

Chairman—F. M. Clark
chemistry and dielectrics consultant, General Electric Co.

Vice-Chairman—E. R. Thomas
manager, Meter and Test Dept., Consolidated Edison Co.

Secretary—C. A. Johnson
chemical engineer, Socony Mobil Oil Co.

Recording Secretary—R. M. Frey
Line Material Industries

A history of Subcommittee IV on Liquid Insulation of Committee D-9 on Electrical Insulating Materials, from which this new Committee D-27 was formed, appears on page 25.

District Activities

President Visits Leading Universities and Industrial Centers on West Coast Trip

President Woods and Executive Secretary Painter Complete 3-Week, 8000-Mile Trip

During their 8000-mile trip extending from February 28 through March 18, ASTM President Kenneth B. Woods and Executive Secretary R. J. Painter spoke at numerous District and other meetings held at leading universities in the Southwest and Far West, and reviewed ASTM work at a number of special gatherings.

The accompanying table summarizes the trip. A number of schools were visited for the first time—this being the result of President Woods' desire to stress, during his term, the interest of the Society in engineering education.

Patterns for most of the meetings were somewhat similar. Following a short talk by Secretary Painter on recent developments in ASTM, including the expansion of Society activities in the educational field, and also including the new Division on Materials Sciences, there was a presentation of students awards. The President then gave the main address dealing either with Polar Construction, Engineering Curricula, or Highway Research. Each of these subjects stimulated much discussion and numerous questions.

Southwest

The Southwest District Council, headed by Earl Berkley (actively assisted by Secretary Frank Chairez, Dallas Vice-Chairman Edwin Joyce, and Program Chairman Briggs Manuel) did a yeoman job in arranging meetings with faculties and students as well as with other guests at Rice Institute and the University of Houston, Texas A & M at College Station, and Southern Methodist in Dallas. In addition, there was an excellent luncheon meeting at the Houston Engineering and Scientific Society's new building, where the Executive Secretary spoke on ASTM activities with other societies. The audience included representatives of most of the leading chapters and sections in Houston. Among those in the audience were ASCE Past-President Mason Lockwood, current ASCE President Waldo Bowman, the superintendents of the two main school districts in the area, and officers of the Houston Engineering Society.

Representatives of ASCE were present at the evening meeting, which was honored by the attendance of Noah E. Hull, a Purdue graduate who was the recipient of the 1959 "Engineer of the Year" award by the San Jacinto Chapter of the Texas Society of Professional Engineers. The two ASTM officers and their wives were present at this dinner. In accepting the award, Mr. Hull emphasized that engineers must establish themselves as true professionals and must resist efforts to downgrade their status.

At Texas A & M, Engineering Dean Fred Benson was the host, arranging a special luncheon meeting of faculty members and presiding at the evening technical session. Many societies and associations are using the fine student union building at College Station for their meetings.

Dean E. H. Flath cooperated closely with District Vice-Chairman Edwin Joyce in Dallas for a luncheon of heads of departments at Southern Methodist and for the evening meeting. Here, as at other schools, tremendous expansion is under way.

Professor William L. Cory, head of the Department of Theoretical and Applied Mechanics, was the host at the University of Oklahoma, where a dinner and technical session were held. Here, as elsewhere, there was keen interest in President Woods' evaluation of engineering curricula. Among those present was Engineering Dean W. H. Carson.

Distinguished Guests at Los Angeles

Among those at the head table at the joint ACI-ASTM meeting: (top) B. P. Weintz, chief engineer, Consolidated Rock Products Co., and Southern California District Chairman; ASTM President K. B. Woods; G. E. Warren, president, Southwestern Portland Cement Co.; E. T. Telford, assistant state highway engineer, State of California; R. J. Painter, executive secretary, ASTM. (upper left) C. W. McKinley, sales manager, Permanente Cement Co.; H. D. McBride, vice-president, Monolith Cement Co.; A. L. McCall, vice-president and general manager, California Portland Cement Co. (lower left) D. C. Honey, vice-president, Riverside Cement Co.; Samuel Hobbs, executive secretary, Southern California Chapter, ACI; J. L. Peterson, president, Southern California Chapter, ACI.

Salt Lake City—West Coast

With P. J. Elsey, assistant director, Engineering Experiment Station, University of Utah, carrying the brunt of the load, and under the direction of Howard E. Montgomery, chairman of the Rocky Mountain District (our newest), an outstanding 2-session Symposium on Explosives and Their Relationship to Materials was held at the relatively new student union building. This occupies a magnificent spot overlooking the city with the Wasatch Mountains in the background. There were eight technical papers by leading authorities:

Seismic Waves from Large Explosions—Joseph W. Berg, Jr., professor, Geophysics Dept., Univ. of Utah

Some Basic Problems in Rock Mechanics—Jack Hoskins, assistant professor, Mining Engineering, Univ. of Alaska; graduate student, Univ. of Utah

Physics of Underground Nuclear Explosions—Gerald W. Johnson, Radiation Laboratory, Univ. of California, Livermore, Calif.

Design of Underground Structures for Atomic Blast Loads—Rudolph Szilard, Colorado State Univ., Fort Collins, Colo.

Explosives for Open Pit Blasting—Melvin A. Cook, director, Institute of Metals and Explosives Research, Dept. of Metallurgy, Univ. of Utah

Earth Moving by Nuclear Explosives—M. L. Merritt, Sandia Corp., Albuquerque, N. Mex.

Testing of Solid Propellants—W. D. Kelley, manager, Quality Control Group, Thiokol Chemical Corp., Brigham City, Utah

Explosives and Underground Effects—George Huber, Stanford Research Inst., Palo Alto, Calif.

The address of welcome by University President A. Ray Olpin was of particular significance since years earlier he had participated in ASTM work and subsequently directed important research activities at the Bell Telephone Laboratories, at Ohio State, and in the Defense Department during World War II. District Chairman Howard Montgomery presided at the morning session and L. K. Irvine, consulting acoustical engineer, who had assisted Mr. Elsey in the program and arrangements, handled the afternoon session.

The evening meeting was followed by an informal dinner at the student union building with District Councilor Melvin W. Jackson, consulting engineer, of Denver, presiding. Following the introduction of guests, which included Experiment Station Head Karl J. Christensen, student awards were presented and President Woods gave an address on Polar Construction. About 145 from all sections of the country were registered for the technical sessions. It is expected that the papers will be published as a special bulletin by the Experiment Station. ASTM members and committee members will receive further information and an opportunity to procure these papers.

This meeting, which might well have been declared a special national technical meeting, brings credit to the new District as well as to Mr. Elsey and those who provided the spark and the hard work that made it such an outstanding success.

Los Angeles

There was excellent attendance at the joint ACI-ASTM meeting at the Young Auditorium. District Chairman Byron Weintz presided, introducing officers of both societies and the head table guests, which included presidents and general managers of leading cement companies in the area, all of whom have supported the work of the Society for many years. It was particularly pleasant to greet George E. Warren, president,

Summary of President's Western Trip, February-March, 1959.

Date	Place	Event	Featured Talk	Sponsor or Host
Feb. 25-28	Houston	Joint luncheon meeting	ASTM joint activities	Southwest District (E. E. Berkley, chairman; Edwin Joyce, vice-chairman; Briggs Manuel, program chairman; Frank Chairez, secretary)
		Student meeting (Rice Institute and Univ. of Houston)	Modern Engineering Curricula	Southwest District
		General District meeting	Polar Construction	Southwest District
		National Engineers Week		San Jacinto Chapter, Texas Society of Professional Engineers (National ASTM officers attended)
March 2	College Station, Tex.	Southwest District meeting, luncheon and dinner	Modern Engineering Curricula	School of Engineering, Texas A & M
March 3	Dallas	Southwest District meeting, luncheon and dinner	Polar Construction	ASCE and Construction Specifications Inst. at Southern Methodist Univ.
March 4	Norman, Okla.	General meeting	Modern Engineering Curricula	College of Engineering, Univ. of Okla.
March 6	Salt Lake City	Symposium on Explosives; dinner	Symposium papers; Polar Construction	Rocky Mountain District and Utah Engineering Experiment Station, Univ. of Utah
March 9	Los Angeles	Dinner and meeting	Polar Construction	Southern Calif. District and ACI Southern Calif. Chapter
March 10	San Francisco	Dinner and meeting	Polar Construction	ASCE San Francisco Section and Structural Engineers Assn., Northern Calif.
March 11	Berkeley	Conference with civil engineering faculties and committee meeting		
March 13	Seattle	Dinner and general meeting	Highway Research	College of Engineering, Univ. of Wash.
March 17	Richland, Wash.	Dinner and general meeting	Modern Engineering Curricula	Local chapters of numerous professional societies

District Activities

Southwestern Portland Cement Co., former ASTM national Director, and for many years chairman of Committee C-1's group on the Cement Reference Laboratory. Ernest E. Magg, chairman of the ACI District, handled the short business meeting for this new group, which has a fine program of activities outlined following the annual meeting of ACI held there in February.

San Francisco

Among the good crowd at DiMaggio's restaurant were representatives of the Structural Engineers Assn. and the Golden Gate Chapter of ASCE, including Chairman Harmer E. Davis, head, Civil Engineering, University of California at Berkeley. Preparatory to the dinner, district councilors reviewed the progress made for the Third Pacific Area National Meeting scheduled for the week of October 11. Details will be given the membership on the outstanding technical program, the ladies' social program, and other special events scheduled (a complete advance program will be mailed to members in May).

President Woods spoke at a special meeting of faculty members at the University in Berkeley on Wednesday, March 11. Representatives from Stanford and Santa Clara Universities attended, and at night the two ASTM officers were guests at a meeting of Professor Davis' ASCE Chapter Committee on civil engineering curricula.

Northwest

Following a dinner meeting at the Hotel Meany in Seattle, where the President and Executive Secretary visited with members of the engineering faculty of the University of Washington, highway officials of the State of Washington, including Director W. A. Bugge, and others concerned with materials, President Woods spoke at a technical meeting in the beautiful music hall at the university. The topic of his address, Highway Research, is a subject of keen engineering interest in the Northwest. There is much construction under way in this area, including a new express highway from Everett to Tacoma, through Seattle. R. G. Hennes, professor of civil engineering at the university, made arrangements for the meetings.

A visit to Richland, Wash., and the Hanford Plutonium Works operated by the General Electric Co. for the Atomic Energy Commission is always most interesting. The entire area around Richland is of great strategic importance in our country's defense and nuclear program. Several of the leading technical men at Hanford are represented in ASTM technical committees, taking an active part in ASTM research and standardization work. The Society officers met officials of both the AEC and General Electric and had a short meeting with ASTM committee representatives and others. Several papers are being prepared at Hanford for presentation at the Third Pacific Area National Meeting in San Francisco.

Of all the personnel in this tremendous operation, possibly 25 per cent are technical men or scientists. Their keen interest in engineering matters was evidenced by the great number of questions at the technical meeting where President Woods spoke on engineering curricula. This was held in the auditorium of a fine junior high school, following a dinner meeting at the Desert Inn attended by officers of the various societies which jointly sponsored the meeting. Robert S. Kemper, an officer of the ASM Chapter, acted for the joint groups and welcomed the ASTM party. D. W. McLenegan, official ASTM representative of the General Electric membership, introduced Messrs. Woods and Painter at the technical meeting, arranged for meetings and contacts with plant officials and personnel, and was assisted by Richard L. Socky, past ASM officer and an active ASTM committee member.

Throughout this trip, much of it made possible in a concentrated period by air travel, the Society officers and their wives were the guests of many ASTM members and friends. They returned with numerous suggestions relating to the Society's work, with names of individuals and companies who should become active, and resolved various questions relating to work of the Districts and to the planning for the Third Pacific Area National Meeting in October.

CLEVELAND

Cleveland District Hears LaQue

"What We Know and Don't Know About Corrosion" was the absorbing talk by ASTM Vice-President Frank L. LaQue heard by an audience of about 150 at the meeting of the Cleveland District, March 31. The meeting was held in cooperation with the Cleveland Section of the National Association of Corrosion Engineers and the Cleveland Chapter of the American Society for Metals at the new Cleveland Engineering and Scientific Center. Ten young men selected by their faculties for outstanding work or aptitude in fields related to engineering materials were honored by receiving student membership prize awards sponsored by the Cleveland District Council. Awards were presented by Mr. LaQue to J. A. Sterk, Joseph A. Danculovic, Rollin H. Teare, James K. Wagner and Melvin S. Klein of Case Institute; and Robert Mellett, Guy Pinter, Alfred Readinger, William Spitzig, and John Vance of Fenn College. The students were introduced by ASTM Assistant Secretary F. F. Van Atta following a brief description of the Society's student prize award program.

Mr. LaQue, vice-president and manager of the Development and Research Division, The International Nickel Co., Inc., who has devoted his entire professional career to metallurgical research and the study of corrosion, stimulated the interest and imagination of his audience by describing several of the known types of corrosion which have plagued engineers and metallurgists, describing known factors and known remedies which have been successful in corrosion control; but at the same time pointing out emphatically that we do not know why certain types of corrosion occur or why remedies are effective. It is known that different combinations of materials and environments produce different types of corrosion but as yet we do not know the mechanisms which cause the corrosion. The types of corrosion discussed as examples were galvanic corrosion, stress corrosion, pitting, impingement attack, and cavitation erosion. Mr. LaQue emphasized that there are great numbers of problems which still offer challenges in research.

In his introductory remarks, Mr. LaQue described the new ASTM Division on Materials Sciences which is being organized to coordinate and intensify the development of knowledge of fundamentals of materials (see ASTM Bulletin, February 1959).

CHICAGO

President Woods Featured Speaker

The Chicago District held a unique smörgåsbord buffet, Monday, March 23, at which ASTM President K. B. Woods was the featured speaker. The meeting got under way at 3:30 p m at the Western Society of Engineers Building in Chicago.

Following Professor Woods' informative, slide-illustrated talk on Polar Construction, the audience participated in the buffet.

President Woods also spoke at a joint meeting of the Chicago District and Iowa State College at Ames, Iowa, Tuesday, April 14 where he again presented his slide-illustrated talk on Polar Construction. Arrangements for the meeting were made by Dean M. S. Coover of Iowa State College.

The Need to Know

By Walter J. Hamburger

This address was presented by Mr. Hamburger at the March 19 meeting of Committee D-13 in New York City, at which he was presented the Harold DeWitt Smith Memorial Medal. This medal is a testimonial to the memory of the late Harold DeWitt Smith, who pioneered the concept of an engineering approach to the evaluation of the properties of textile fibers. Mr. Hamburger has enjoyed a distinguished career as an engineering executive, inventor, lecturer, consultant, and author in the textile field. He is director of Fabric Research Laboratories, Inc.

In 1944, Harold DeWitt Smith delivered before ASTM the first Marburg Lecture dealing with textiles. His was an eloquent presentation of both what was known and what needed to be discovered about the engineering properties of textile materials. In 1955, it was my honor to follow DeWitt Smith as the second textile Marburg Lecturer and at that time I was able to say: ". . .more has been achieved, scientifically speaking, in these eleven years than in the entire previous history of the textile industry." I might add now that in the past four years I have noticed absolutely no retardation of scientific progress in textiles.

As a result of our research, we can now rigorously predict yarn properties mathematically in consonance with theories of applied mechanics. We are not quite as good at predicting fabric properties, and one gigantic area of research—as yet practically untouched—stands in the way of a thorough understanding of the physical properties of textile materials. This I choose to call *microstrains*—fiber strains on the order of less than 1 per cent, and an understanding of microstrains should now be one of the major goals of those of us who have devoted our lives to textile research. It appears to me that before we can understand, predict, and design fabrics with excellent qualities of hand, luster, drape, bulking, warmth retention, insulating value, contact value, and other more-or-less scientifically undefinable characteristics, we must understand microstrains.

Let me give you a few examples of what we consider to be the influence of these very small strains.

A top quality wool suit, well pressed, is purchased and rather than being worn immediately, it is hung on a clothes-hanger in a closet where the humidity is high. Overnight, the suit becomes so disheveled that it must be pressed again before it can be worn. Von Bergen and Clutz have termed this phenomenon RH motion in wool. Each moisture-sensitive fiber has deformed only slightly, certainly in the microstrain region, but the gross effect has significantly altered the appearance of the fabric.

Another example occurs in carpets. These are frequently tacked wall-to-wall on the floor of a suburban home in the

Walter J. Hamburger (left) receives the DeWitt Smith Memorial Metal and congratulations from B. L. Whittier, chairman of committee D- 13

. . . Distinguished Career in Textile Science

"[The name of Walter J. Hamburger] appears on an endless list of patents, papers and publications, and professional activities almost too numerous to mention. For instance, lecturer, visiting professor, adjunct professor at such distinguished institutions as the Massachusetts Institute of Technology, Simmons College, Polytechnic Institute of Brooklyn, and Lowell Technological Institute; with numerous chairmanships in military, governmental, and civilian committees. His memberships and the positions he has enjoyed reflect the scope of his activities and contributions—a member of Sigma Xi; fellow and vice-president of the Textile Institute of Manchester, England; member and past-president of the Fiber Society; honorary member of the American Association for Textile Technology; member and trustee of the Textile Research Institute; member and past-councilor of the American Association of Textile Chemists and Colorists; and many others, including membership and activity in our own Committee D-13.

"A recipient of many honors—to name but a few; honorary degree of Master of Science, Lowell Technological Institute, 1952; Certificate of Distinction of the Polytechnic Institute of Brooklyn in 1956; and the Olney Medal of the American Society of Textile Chemists and Colorists in 1956. Of particular significance and decidedly germane to this occasion was the honor bestowed on our Medalist in being selected to deliver the twenty-ninth Edgar Marburg Lecture, the tenth to follow the famous lecture by Dr. Harold DeWitt Smith.

"These two classic lectures, the 19th by Dr. Smith and the 29th by Dr. Hamburger, are a 'must' for every textile man's library. If you do not have them, order them at once—but more important, read them—be inspired by them. In so doing, you will gain an understanding of the stature of both of these great scientists."

Excerpt from presentation remarks delivered by Richard T. Kropf, vice-president of Belding Heminway Co., Inc., and past-president of ASTM.

summer when relative humidity is high. Winter comes, the humidity drops, and the backing filling yarns grow on the order of 0.2 to 0.4 per cent, but these microstrains are sufficient to cause the entire carpet to grow, causing ripples, bad appearance, and—just incidentally—many consumer complaints.

Fluffed-up, low-density yarns made of cross-linked rayon fibers, such as those presently being introduced on the market, which have a higher torsional rigidity relative to bending rigidity than do ordinary rayon fibers, are another example. Without going into detail, the fluffing-up is caused by the development of microstrains which increase the radius of the helix assumed by the fiber as it lies in the yarn.

Filters and other industrial fabrics in which air or liquid permeability characteristics affect proper functioning are also influenced, we believe, by microstrains where a very small linear change creates a gross area change and the material ceases to function properly.

Therefore, in concerning ourselves with microstrains, we are not only concerned with aesthetic properties, but with functional and sometimes critical ones as well.

Up to this point, I have offered no absolute proof that an understanding of microstrains will give us the ability to define mathematically some of the presently nebulous fabric characteristics. In fact, at this point, there can be no *absolute* proof. However, our reasoning is based on more than simple conjecture. In many applications of accepted elastic theory we assume that all elements of a system must have freedom of motion. On this concept is based much current knowledge of applied yarn and applied fabric mechanics. Now, if we have come close to the right answers after making this assumption—and I am sure that we have—then it becomes obvious that the micromotion of individual fibers in a yarn or fabric greatly influences functional behavior.

Some exploratory research has already been done in these areas and, in fact, we have done some in our laboratories. However, the key has barely been placed in the lock. Before we will know the answers we must thoroughly study and understand microstrain behavior—and there is here need for new instrumentation similar to what has been developed for the study of macrostrains. We must also thoroughly study and understand the surface characteristics of fibers as they govern the ability of fibers in a yarn of fabric to *move*, as this, obviously, is equally crucial to a solution of the problem.

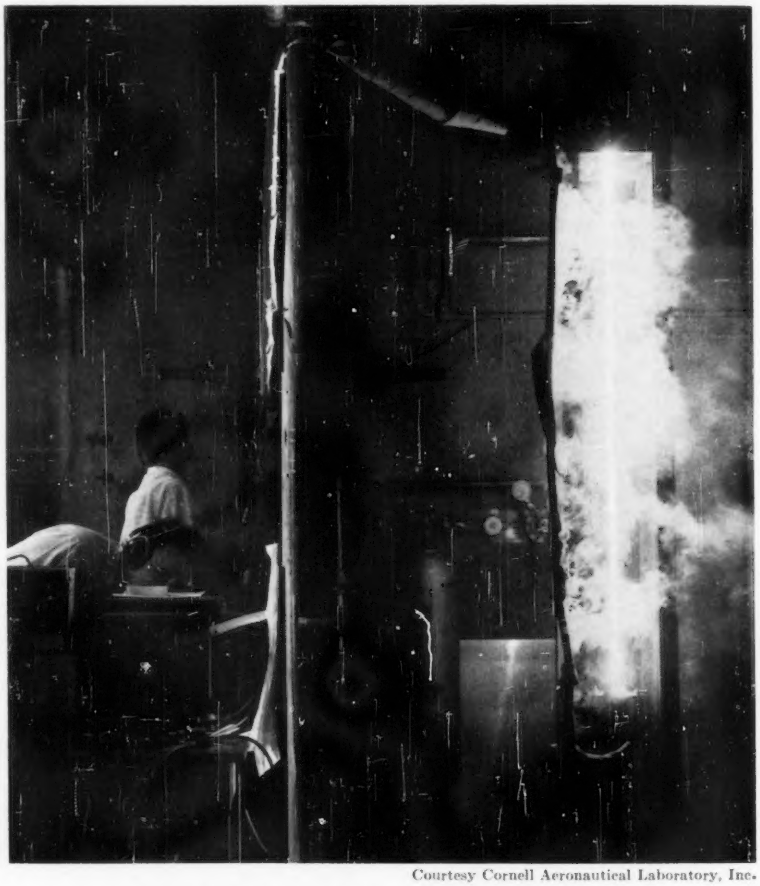
I believe that concerted research efforts aimed at an understanding of microstrains is an important step toward a really thorough understanding of the physical behavior of textile materials—an understanding that must be achieved if textiles are to maintain their just place in a competitive economy.

New Use for Plastics Subject of D-20 Study

Thermal ablation is the subject of a two-session symposium to be held at the **Third Pacific Area National Meeting, Oct. 11–16,** under sponsorship of Committee D-20 on Plastics. H. A. Perry of Naval Ordnance Laboratory, White Oaks, Md., who is arranging the program, told the Society of Plastics Engineers at its January 1959 meeting in New York that reinforced plastics have long been known to stand up for short periods at temperatures up to 2500 C and were suitable for use as shell casings. This performance made them a natural for investigation as potential rocket nose cone materials and for jet deflectors and interior surfaces of rocket motors. It is now experimental fact that certain types of reinforced plastics can take higher temperatures than practically all other materials for the short periods needed to protect rocket instrumentation in the nose cone and for similar high-temperature, short-time applications.

Thermal ablation is the term used to describe what happens to a material under these conditions and includes spalling, sloughing, sublimation, runoff, evaporation, pyrolysis, and combustion. Mechanical effects include impact erosion and shearing.

How to test candidate materials and how to explain the mechanism of thermal ablation are subjects of extensive and intensive investigation among members of the ASTM plastics committee as well as in many research laboratories.



Courtesy Cornell Aeronautical Laboratory, Inc.

What happens to a material under these conditions?

At Cornell Aeronautical Laboratory, Inc., a plastic specimen is tested under conditions simulating missile re-entry from outer space. A high-velocity gas passes upward through a graphite-tube furnace heated by a million watts and strikes the specimen mounted at the top. Temperatures reach several thousand degrees. These ablation studies are carried out for Wright Air Development Center.

Electrical Insulating Liquids 1916–1959

The Story of Subcommittee IV, Committee D-9

By C. A. JOHNSON[1]

THE ESTABLISHMENT of Committee D-27 on Electrical Insulating Liquids and Gases in February closes the history of a subcommittee of Committee D-9 on Electrical Insulating Materials which started with modest aims in 1916. In that year a small group of petroleum refiners, utility operators, and electrical manufacturers formed a separate Subcommittee on Liquid Insulation, under the chairmanship of P. J. Agnew of the National Bureau of Standards. By 1920, Subcommittee IV, as it became known, had a membership of 18 to 20 members, who were studying dielectric strength, sludge, neutralization number, and other qualities of insulating oils. In 1920, the chairmanship was assumed by Florus Randall Baxter of Vacuum Oil Co. He was succeeded in 1925 by the late Edgar Ambrose Snyder, then with General Electric Co. at Pittsfield, Mass. Mr. Snyder later became affiliated with the Vacuum Oil Co., and continued as chairman until his retirement from active service with Socony Mobil Oil Co., Inc. Frank M. Clark of General Electric Co. became chairman in 1951 and continued until the expansion of Subcommittee IV into Committee D-27 in February, 1959. A listing of the personnel in 1926 will revive memories among the senior members of Committee D-27:

Subcommittee IV—1926

F. R. Baxter, Vacuum Oil Co.
H. J. Beattie, General Electric Co.
J. T. B. Bowles, Crown Central Petroleum Co.
T. G. Delbridge, Atlantic Refining Co.
Delafield Du Bois, Safety Cable Company of Bayonne
I. K. Giles, Warner-Quinlan Co.
J. G. Ford, Westinghouse Electric and Mfg. Co.
A. L. Clayden, Sun Oil Co.
C. F. Hansen, R. T. Vanderbilt Co.
A. E. Flowers, De Laval Separator Co.
Dean Harvey, Westinghouse Electric and Mfg. Co.
Max Hecht, Duquesne Light Co.
K. G. MacKenzie, The Texas Company
F. V. Magalhies, New York Edison Co.
R. S. MacPherran, Allis-Chalmers Co.
L. W. Parsons, Tide Water Oil Co.
E. A. Snyder, Vacuum Oil Co.
H. S. Vassar, Public Service Electric and Gas Co.
E. D. Tanzer, Day and Zimmerman

Advisory Members

C. E. Lanning, Standard Oil Co., Bayonne, N. J.
C. P. McNeil, Standard Oil Co., Whiting, Ind.
E. E. W. Oke, Canadian General Electric Co., Toronto
G. S. Parlour, Canadian General Electric Co., Petersboro, Ont.

Not only are many of these names unknown to the present membership, but even the company designations have changed over the past 32 years. Now, in 1959, the committee has grown to an organization of 85 members representing more than 60 manufacturing and consuming companies, and divided into 28 sections carrying on standardization activities in the field of testing liquid electrical insulating materials.

Aim: Tests to Indicate Performance

Certain sections which worked on the preparation of tests for evaluating oxidation life in a short period, evaporation loss, and the correlation between interfacial tension and saponification number have failed to reach practical conclusions. Other sections find the results of their cooperative work reflected in the increasing volume of testing procedures now standardized and universally accepted throughout the industry.

Probably one of the most widely used test procedures in the evaluation of insulating oil is the determination of neutralization number. Since both of the existing ASTM methods in use, D 664 and D 974, are under the jurisdiction of Committee D-2 (Petroleum), any work in Subcommittee IV on these methods is limited to their specific application to insulating oils. For example, both of these general methods require that the samples be heated to 60 C and filtered before testing. Work in Subcommittee IV showed that this step was unnecessary for transformer oil and a note was added to both methods, permitting omission of the heating step for oils visibly free of sediment. Tests comparing the use of 0.01 N caustic solution with 0.1 N solution have indicated that the two solutions gave equivalent results.

A field test procedure recently prepared at the request of the AIEE determines the approximate acidity of used insulating oils of petroleum origin. The application of this method to askarels is under study.

A second group is preparing methods of test and standardizing equipment for determining the stability of electrical insulating liquid in combination with electrical insulating paper.

Sludge Testing

The scope of activity on sludge testing originally included only the development of test procedures pertaining to sludge formation in mineral transformer oils, but now includes oxidation tests for electrical insulating liquids. The present scope covers test methods for determining the oxidizing tendency of inhibited and noninhibited electrical insulating liquids and the correlation of the results with the behavior of these liquids in service. The coordinated work of this group has resulted in the adoption of the high pressure oxygen bomb method as a standard (D 1313), the authorization of the sludge accumulation test as a tentative method (D 1314), as well as the completion of a ten-year study of insulating oils in service, involving the use of a variety of test procedures and oils in 18 transformers. Various symposia have been based upon the data obtained from these studies.

When an oil in service starts to deteriorate, and contains sediment and decomposition products, a procedure must be available for accurately determining the amount and general composition of this sediment as well as for measuring the incipient formation of sludge. Such a method is now available, which measures organic sediment, inorganic sediment, and soluble sludge. Chemical and spectrographic analysis of the isolated sediment is possible, if an operator wishes to go to this end. Present work along these lines aims to improve the accuracy of the procedure.

An extensive round-robin study of an oxidation method, sponsored by the In-

[1] Chemical engineer, Socony Mobil Oil Co., Inc.; secretary of Committee D-27 on Electrical Insulating Liquids and Gases.

ternational Electrotechnical Commission, involved a comparison of the use of soluble and solid metal catalysts. The data, reported at a 1957 symposium, appear in *Special Technical Publication 218*.

Since many technical people feel that the presence of copper in electrical insulating oil is a result of deterioration, efforts are being made to develop methods for the quantitative determination of copper in these oils. It is hoped that such methods will be useful in evaluating transformer and cable oils from service and in studying the phenomena which occur during service deterioration.

Cooperative studies are now being made of the application of a neocuproine method for the spectrophotometric determination of copper in uninhibited transformer oil without any prior separation of the metal, and of a rotating-disk, electrode-emission, spectrographic method using cobalt as the internal standard and a lithium buffer.

Saponification number has not been widely used in examining insulating oils. It is not generally used in the industry in evaluating either new or used oils, but is of considerable value in the comprehensive study of any new type of oil or for special field service problems. It is useful as one measure of the presence of oxidation products, either as added compounds or contaminants. From time to time efforts have been made to prove a connection or relationship between saponification value and interfacial tension, neutralization number, and other test criteria, but no unshakable relationship has as yet been confirmed.

Sampling

Details of sampling procedures have been under study for several years. New methods, techniques, and suggestions are constantly being reviewed in order to supplement the present sampling method, D 923, and to make it a complete guide for sampling all types of containers and apparatus containing insulating fluids. The desirability of taking bottom samples and of sampling oil in cables is now under study. Vacuum and flushing sampling methods which may be applicable to cable oils or to sampling under conditions of high humidity are the most recent problems in this field.

Use of statistical analysis has enabled the subcommittee to publish statements on repeatability and reproducibility and to provide comparisons between competing test methods. It has helped to determine the statistical significance or nonsignificance of factors affecting the accuracy of results. The limitations of a test method are better understood by reason of this information, which thus helps to devise an improved method.

AIEE Collaborates

Development work on the testing of cable oils and preparation of specifications were started about 1935. At that time they excited moderate interest, only to be dropped as the war approached. In 1953, this investigation was revived and the interest in cable oil testing was sparked by the appointment of a liaison representative to the Insulated Conductor Committee of the AIEE. A review of the insulating oil test methods showed that many were applicable without change to cable oils, but others required modification so that the higher viscosities of the cable oils would not result in excessive variations in test results. Collaboration with the AIEE in these intensive studies has helped to increase the knowledge and perspective of Subcommittee IV.

Requests for help in preparing testing procedures are frequently and correctly referred to ASTM. When the AIEE had need for a standardized visual and field method for examining new and used oil, a group in Subcommittee IV undertook to supply one. A method for the visual examination of used electrical oils in the field has been prepared and is now in use. The same sort of standard procedure for the examination of used askarels is now being sought.

Emulsion tests, either with steam or water, have long interested mineral oil technicians. Prolonged controversies have continued on the merits of these tests and their relative worth in evaluating oils, either new or in service. The steam emulsion test, first introduced in 1927 and last revised in 1936, has had its violent adherents and antagonists, ending with the withdrawal of the test procedure several years ago. A group was organized in 1951 to try to bring some order out of the chaos. After various modifications in the procedure failed to bring agreement, emulsion tests with air were tried, with indifferent agreement. Still, many users of insulating oil feel that some test involving emulsification with air, water, or steam is a useful indication of the condition of oil in service and efforts to devise a workable test are continuing.

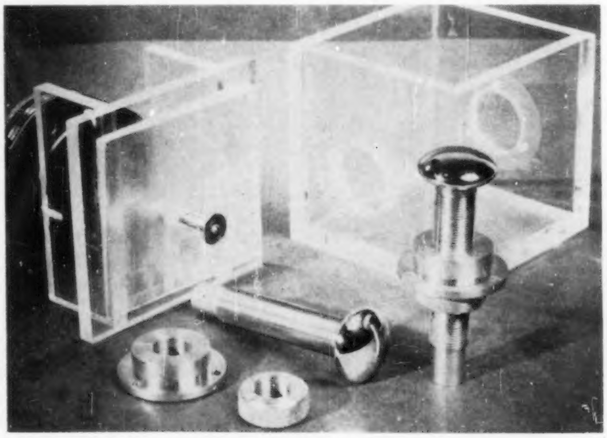
Subcommittee IV has recently prepared a new standard method for the determination of the antioxidant additive, ditertiary butyl *para* cresol, in new insulating oils. The usefulness of this method in determining the remaining antioxidant in a used transformer oil is now being studied.

Dissolved Gases

In the testing of insulating oils to some extent, and particularly in cable oils, dissolved air and other gases must be determined and removed. Application of the test method to the heavier oils used in cables has been more difficult and has required modification of the method. Lack of a suitable container for a sample was one of the details which delayed work of this nature, now under way.

Electrical Tests

The electrical properties section has carried out tests on a standard power factor unit, for checking the accuracy of bridges used for power factor measurements. Other tests have been undertaken to compare the accuracy of a two-



Cell for VDE Gap Test

Dielectric strength is considered by many to be the most important electrical characteristic of an insulating liquid.

electrode cell with that of the ASTM three-electrode cell for both power factor and resistivity measurements on new and used insulating oils. Test techniques and preparation of the test specimen appear to be equally as important as the availability of a preferred method for cleaning the test cells.

Dielectric strength is considered by many operators to be the most important electrical characteristic of an insulating liquid. Although many have felt that the procedure for its determination left much to be desired, yet it has withstood the test of time until recent years. One learned technician has observed that the dielectric strength value reflects all the faults in the oil. A new procedure under study seems destined to select the outstanding oils from those of good commercial quality. Called the "VDE gap test" which originated in Germany it may, when standardized, become a research apparatus or a routine tool of measurement.

Variety of Tests

Developments in the industry often indicate the need for new testing procedures. With the increased use of cable oils and the development of high-tension cables, oils are serving under conditions of extreme electrical stress. A means of determining the electrical resistance of a cable oil to high temperature exposure is being explored by the subcommittee.

The ill effects of moisture in insulating oils and the cumulative effect of this moisture in appliances have been well known for many years. Moisture could be roughly determined by several different procedures, but the detection of small amounts in the region of parts per million was difficult. Water by extraction was the first test procedure having the required accuracy. It was followed by a second method using the chemical mixture of iodine and sulfur dioxide, known as "Karl Fischer reagent." These methods are accurate with both new and used oils and are valuable service tools.

With the increased use of the nonflammable electrical insulating liquids, known as askarels, the need arose for standardized test procedures for the various characteristics of these fluids. A group in Subcommittee IV has now completed the general test procedures. These will be found in ASTM Methods D 901, which represent the result of several years of dedicated effort. New field tests for askarels and new developments such as the "scavenger" content are now under consideration.

Technicians on the alert for early vestiges of oxidation believe that this manifests itself in the formation of peroxide bodies. The demand for a method for determining the presence of these bodies has been met by ASTM Methods D 1563.

Several possible criteria for uniformity of cable oils and allied products are the specific optical dispersion and index of refraction. The procedures for their measurement require delicate instruments and a high degree of technical skill. Such methods are subjected to standardization rules to remove the greatest number of variables. Work now under way should produce ASTM methods for referee measurements.

When a new material of unknown characteristics is offered for use as an insulating liquid, the limits of its operating usefulness must be ascertained. Preparation of a proposed recommended practice for estimating the relative temperature limits of usefulness of dielectric fluids has taken considerable thought and ingenuity. Obvious defects might appear at once in some fluids, but others would have to be subjected to a series of elimination trials to prove their worth. A method for such a procedure is being explored.

Corrosion by sulfur and sulfur compounds is an ever-present hazard in insulating oils; all mineral oils contain sulfur in varying amounts. A somewhat inconclusive method in use for many years was finally judged to be inadequate. A technical group first devised a procedure for evaluating the effect of free sulfur, then went on to a study of the effects of combined sulfur. This more severe procedure guards the user against the effects of corrosion and detects sulfur in combination, which may be detrimental under some conditions.

Petroleum tables for determining the expansion coefficients of mineral insulating oils of petroleum origin have been in use for many years. It was not at once certain whether these tables would apply to the askarel type of fluids. Tables for calculating the expansion rates of both heavy and light mineral oils and askarels of varying viscosities are now being prepared.

Mineral oil for use in both high- and low-pressure cables is under electrical stress in service and may deteriorate due to gas evolution. Apparatus for calculating this tendency has not been widely available. The procedure has been subject to private techniques with reproducibility established by long practice. Efforts to standardize encountered difficulties both in the apparatus as well as in the step-by-step procedure. A start has now been made, and ultimately a method for determining the tendency of an insulating liquid of petroleum origin to evolve gas under test as well as in service will be available.

A new field of thought opens with the need to determine whether insulating oils may dissolve metals. In service, the oil bathes metals such as copper, brass, and iron, with accompanying heat and voltage stress. A technical group is exploring the effects of this association. The investigation is in its preliminary stages.

Specifications

The preparation of specifications for insulating oils has been dependent upon the adequacy of the testing methods available. It was felt that if a complete coordination with service life could not be written into a specification, at least a screening specification suitable for purchase use could be assembled. Accordingly, limits were established for dielectric strength, neutralization number, free sulfur corrosion, viscosity, and flash, as well as pour point. Later work established acceptable limits for combined sulfur and interfacial tension. The newest additions to the screening specification for purchase are inorganic chloride and sulfate limits, and a power factor requirement.

Symposia

A history of Subcommittee IV would not be complete without reference to its several symposia, in which expositions of service runs, data collected, experiences in operation, and the several more controversial test procedures and evaluation methods have been frankly discussed. A forum of this nature furnishes an excellent arena for an exchange of points of view, and the accumulated results of years of cooperative effort show here to better advantage than in the studied phrases of the standardized method. The symposium was early adopted as a means of publishing information which later might be forgotten and lie buried in files of the past. The subject list has been a varied one touching on many facets of the industry. Altogether, seven symposia on insulating oils sponsored by the committee have been published by the Society.[2]

It is to be hoped that these seminars will be continued under the new Committee D-27 on Electrical Insulating Liquids and Gases. They have been a source of interest not only to the membership of Subcommittee IV but to many other technical people who should be attracted by the developing role of the new committee. The growing use of gases as dielectrics has opened a new field for testing and the preparation of new methods for evaluating gases is a challenge to the skill of the industry.

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[2] ASTM Bulletin, May, 1947 and Dec., 1947. *Special Technical Publication Nos. 95* (1949), *135* (1952), *152* (1952), *172* (1954), and *218* (1957).

Technical Committee Notes

Coal and Coke

Committee D-5 Sends Representative to Paris ISO Meeting

THE STANDARDIZATION of international methods for testing coke is handled by Working Group 8 of ISO/TC 27 on Solid Mineral Fuels. Committee D-5 on Coal and Coke sent W. L. Glowacki to act as the United States Delegate at the latest meeting of this Working Group, held in Paris on January 26 and 27, 1959. Some 26 delegates from 11 countries met to discuss methods of testing coke for mechanical strength, size analysis, specific gravity, porosity, chemical constituents, and reactivity.

The ISO/TC 27 work on mechanical strength of coke has centered on the European Micum test and the British shatter test. The Micum test involves the tumbling of coke in a rotating drum and in this respect is similar to the ASTM tumbler test. The shatter test is much like ASTM Method D 141 – 48, except that the British test calls for square-aperture, punched-plate sieves. Mr. Glowacki, pointing out that Method D 141 calls for woven wire sieves, presented data from his laboratory showing the measurements of the apertures of a $1\frac{1}{2}$-in. woven wire sieve. He requested that woven wire sieves be permitted as an alternative to square-aperture punched plates. This was accepted in the following language:

> "Woven wire sieves may be used provided they give the same results, to limits to be decided later, as those given by machine stamped sieve tests."

Mr. Glowacki had the assignment to present the Tumbler Test for Coke (D 294) for consideration by Working Group 8 as an ISO standardization project. He stated that the tumbler test had become almost universally used in the United States and that considerable published data were available to show that this test provided useful parameters to characterize coke performance in the blast furnace. The test could hence be considered indicative of the carbonization characteristics of coal, and much coal has been exported by the United States to Europe for carbonization purposes. Mr. Glowacki noted that there was only one Micum apparatus in this country and that was located in Boston (shortly thereafter the apparatus at the Bureau of Mines in Pittsburgh was constructed).

Working Group 8 agreed that the question as to whether or not the tumbler test should be presented for consideration as an international standard would be deferred to the next meeting and that at that time decision would be based upon data comparing the Micum with the tumbler test. Such data will be obtained in the meantime by the British, German, and Italian delegations. Mr. Glowacki had informed Working Group 8 that his company and the U. S. Bureau of Mines both had planned programs for making such comparisons.

Other items covered by the meeting included a discussion of proposed work on the preparation of methods for chemical analysis and size analysis. No immediate experimental work is planned on the reactivity of coke. It was decided that it would be desirable to have ISO methods for bulk density, true specific gravity, apparent specific gravity, and porosity.

Acoustical Materials

Mounting, cleaning, painting, fire resistance of acoustical tile under study

Mechanical suspension systems have become the most popular method of mounting acoustical tile in modern building construction. Committee C-20 on Acoustical Materials has been asked by the industry to develop ASTM standards for this field. Most of the manufacturers of these suspensions are enthusiastically supporting this project, as was evidenced at a meeting of Committee C-20 held at the University Club, Chicago, Ill., on April 16. Task groups have been organized to develop preliminary information such as surveys of the field for uniform methods of testing and reporting; to establish liaison with the Acoustical Materials Assn.; and to analyze the components. Each of the primary components will probably need separate study. Liaison will also be established with other ASTM committees.

Another current field of interest in the committee, which is also a departure from the usual consideration of standards on materials only, is in the field of maintenance of acoustical materials. The committee, since its organization, has been attempting to develop what might be called recommended practices for cleaning and painting acoustical tile as well as to determine the effect of painting on the performance of acoustical tile. The responsible subcommittee will now focus its attention on a method of repainting acoustical tile. Consumer representation is particularly needed in this activity.

Fire resistance is considered an important property of acoustical tile and because of this a subcommittee has been reviewing available test methods and also participating in test programs. The subcommittee recently sponsored an interlaboratory program to correlate tests on four types of acoustical tile using the "large tunnel" test apparatus described in ASTM Method E 84T. Four laboratories participated, with the cost of the program being underwritten by the acoustical materials industry. The final report, including a supplementary report of tests conducted on the radiant panel and the "small tunnel" test procedure, was accepted by the committee. The general conclusions and recommendations of the report indicate that the program was very much worth-while but that better correlation would result if certain variations in the several furnaces were corrected. The committee recommends that further round-robin tests be conducted following an attempt to correct these variations.

The basic field of sound absorption continues to receive the attention of the responsible subcommittee. Minor revisions in the new reverberation room method (C 423T) have been tentatively approved subject to letter ballot. A new draft of a small-scale box method has been prepared and will be submitted for publication in the ASTM BULLETIN. Meanwhile, a round-robin test program will be conducted using three sources of apparatus. The committee is conscious of the need for an in-place method, with two types of apparatus being considered. Data on the correlation between small-scale and large-scale tests are also being collected.

Flexible Barrier Materials

Development of a test for seam strength, an important property of flexible barrier materials, was given priority by the new Committee F-2 on Flexible Barrier Materials at its spring meeting at the Sheraton Towers in Chicago, Ill., April 15. Two procedures included in a proposed method now receiving final approval in the subcommittee are a static-load and a dynamic-load test. Of equal importance are such properties as water-vapor permeability and gas transmission—task groups reported very encouraging progress in the development of test methods for these two properties. In addition, such properties as tear impact, bursting and tensile strength, as well as chemical properties, are assigned to task groups.

The need for definitions, particularly of such basic terms as "barrier," "flexible," "material," and "permeable" have been given concentrated attention by the Subcommittee on Definitions. This group has now recommended to the main committee the acceptance of definitions for these four terms. A number of additional terms received initial review at the meeting.

The Subcommittee on Specifications has been formulating its approach toward the general objective of preparing specifications for flexible barriers. It is recognized that the group is not in a position to write specifications at this time, but two projects will be attempted: (1) Establish a listing of the various markets, the significant properties or characteristics needed in each market, and the conditions under which flexible barrier materials are used. (2) Advise the Subcommittee on Methods of Test of the test methods which are needed in the preparation of specifications and therefore should have priority in their development.

The organization of a new Subcommittee on Liaison has been approved. The functions and composition of this type of subcommittee were discussed at some length. Since the status of Committee F-2 in its relations with other technical committees of the Society, as well as outside groups, is particularly dependent upon close liaison with these groups, this subcommittee will centralize all liaison matters and will include as its members all liaison representatives.

Shipping Containers

Progress on simulated service tests, stacking performance

Vibration, inclined impact, drop, and the revolving drum test are a group of simulated service tests which have interested Committee D-10 on Shipping Containers for some time. Further refinement of these test procedures is needed to permit adequate correlation between different installations so that performance standards can be developed. At the spring meeting at the Shoreland Hotel, Chicago, Ill., on April 14, the working groups reported on the status of a number of round-robin tests which have been conducted to secure the necessary correlation data. It was evident in some cases that further round-robin test programs were desirable and these have been organized. In the case of the revolving drum test, more work has been agreed upon to establish a means of rating containers. In this program, fiberboard containers of varying weights will be used. A redraft of the test method will be circulated to the subcommittee members. The test program involving vibration has shown the need for research of a more fundamental nature in order to provide basic data. In the round-robin tests on the inclined impact procedure, the accelerometer as mounted on the rigid block showed considerable variation. This condition will be studied further to establish the required rigidity of the backstop.

Study of a test method for evaluating the stacking performance of shipping containers has continued, with the subcommittee reviewing tests conducted at Eastman Kodak Co. and the Forest Products Laboratory. The possibility of using deflection to predict stacking performance is also under consideration. A new title, "Methods of Testing Compression under Static Loads," was agreed upon.

With the former task groups now recognized as full-fledged subcommittees, a planning group has been organized, to be known as Subcommittee II on Appraisal. It is expected that this group will be of great value in reviewing existing standards to determine which methods require further study, to assign priority to such studies, and to analyze all new projects that come before the committee.

E-29 Rounding-Rule in Controversy

When the Recommended Practice for Designating Significant Places in Specified Limiting Values was made a standard in 1950 it was considered then to be the best procedure available for comparing individual test values in determining conformance with specifications. The 1950 standard had a further advantage in that it could also be used for rounding off individual results which were to be averaged or otherwise handled statistically, without introducing any cumulative error. The one disadvantage was that the method was a little difficult to use.

In 1958, Committee E-11 proposed and had accepted a revision of this standard which, while it would simplify the method of application (specifying that figures ending in 5 or greater would take the next higher value and those below 5 the next lower for the number to be retained), would cause the introduction of a cumulative error if it were used for other than comparing a single value with a specification value. For rounding off groups of test results for computations one should continue to use the 1950 standard, or its equivalent–American Standard Z25.1-1940.

The 1958 revision of the recommended practice E-29 has been the object of a number of strong criticisms. One committee feels that reference to the revised recommended practice in its specifications is inadvisable since, in some cases, the actual specification values are changed. This committee is taking steps to eliminate references to the 1958 revision, referring instead to the American Standard Z25.1.

While Committee E-11 on Quality Control of Materials, which promulgated this standard, is of the opinion that the revised standard is quite satisfactory for its intended use, it is quite willing to go back to the previous standard version if sufficient evidence is presented that this should be done. The committee is, therefore, scheduling a meeting on **Monday afternoon, June 22, at the Annual Meeting,** where the E-29 rounding-off controversy will be discussed. An attempt will be made to arrive at a consensus among the representatives of ASTM committees as to what should be done—whether to retain the present revised version or to go back to the 1950 standard version.

End-Use Products

ACEUP Is No More

In 1945 the Society organized an Administrative Committee on Ultimate Consumer Goods (renamed Administrative Committee on End-Use Products, November, 1956), with the following scope:

(1) To promote knowledge of engineering test methods for end-use products; (2) to encourage and stimulate investigations for the above purpose, both from the engineering point of view and from that of the fact-finder seeking to determine the needs and wants of the user of end-products; (3) to advise with and assist technical committees which may desire to establish measures or scales of performance, or standards for end-use products based on their test methods; (4) to review annually for the Society progress in the

Technical Committee Notes

field of testing of end-use products and in the development of standards for such products.

The committee for a number of years worked hard to clarify the Society's position in the consumer goods field, especially in view of the then national administration interest in setting up standards for consumer goods. There have been changes in administration policies since the committee was organized and the committee's status has been discussed at several recent meetings of the Board of Directors. In January of this year, based on a recommendation of the committee that it be placed on a standby status or be discharged, the Board took unanimous action to discharge the committee with thanks.

In taking this action the Board of Directors accepted another recommendation of the committee at its final meeting last December to call a conference of interested companies and individuals to determine the need for a new committee to develop test methods for evaluating consumer preferences and other types of tests where subjective factors are involved. Such areas include standard tests for taste and odor, as well as appearance, comfort, etc., of materials. Plans for this conference are going forward and anyone interested is invited to write to Headquarters.

During its existence the Committee on End-Use Products chalked up a number of notable accomplishments. It sponsored a Symposium on the Measuring of Consumer Wants in 1951, which was published by the Society as STP 117. The committee also drafted a proposed format for standards covering ultimate consumer goods which was published in the ASTM BULLETIN. The committee held numerous meetings and reviewed on several occasions the Society's work related to the consumer goods field. Many materials used industrially, which are subjects for committee activity, also fall in the consumer-goods category, or at least in the institutional type goods field. Such products include floor waxes, antifreeze, fuels, paints, textiles, plastic film and sheeting, soaps and detergents, etc., which are covered by ASTM committees.

Even though the Committee on End-Use Products has been discharged, the Society's interest in these fields, particularly the institutional materials field, continues and there is active representation by the Society on the ASA Sectional Committees dealing with these materials, including Sectional Committee K63 on Institutional Maintenance and Supply Materials, and the various committees in the "L" series covering textile materials.

Chairman of the Administrative Committee was Professor H. J. Ball of Lowell Tech, former President and Honorary Member of the Society. Other members of the committee at the time of its discharge were: R. D. Bonney, A. L. Brassell, Jules Labarthe, W. S. MacLeod, Paul S. Olmstead, and A. F. Tesi. Former members included: A. W. Carpenter, A. G. Ashcroft, T. A. Boyd, H. Morgan, G. C. MacDonald, and G. N. Thompson.

Oak Ridge Sets Conference on Analytical Chemistry in Reactor Technology

THE OAK RIDGE National Laboratory has announced that the Third Conference on Analytical Chemistry in Nuclear Reactor Technology will be held at **Gatlinburg, Tenn., Oct. 26–28, 1959.** Present plans call for two sessions on each of the three days, to cover such topics as: the analysis of spent reactor fuels, corrosion and erosion products, and fission product mixtures; and analytical chemistry of exposed blanket materials, reprocessing fuels and blanket materials, and plutonium and transplutonic elements.

Papers for presentation at the conference are solicited. Proceedings of the conference will be unclassified, and all interested persons are invited to attend or participate. All requests for further information should be addressed to C. D. Susano, Oak Ridge National Laboratory, P. O. Box Y, Oak Ridge, Tenn.

Program Announced for International Rubber Conference

A COMPREHENSIVE technical program has been organized for the International Rubber Conference to be held in **Washington D. C., Nov. 8–13, 1959.** The conference is sponsored jointly by the American Chemical Society's Division of Rubber Chemistry; the Rubber and Plastics Division of The American Society of Mechanical Engineers, and ASTM, through Committee D-11 on Rubber and Rubber-Like Materials. Many aspects of rubber manufacturing, properties, applications, test methods, and classification will be covered. The program:

Monday, Nov. 9

Equipment and Processes in Rubber Manufacturing

The Rotomill—A Continuous Mixing Device—A. E. Juve, J. R. Beatty, and R. H. Kline

New Rubber Processing Techniques for the 60's—A. H. Hale

Basic Equipment for Producing Flexible and Rigid Polyurethane Foams—J. M. Buist

Elastomers as Engineering Materials

Elastomers in Naval Machinery—E. M. Herrman, J. S. Post and S. U. Patton

Urethane Polymers as Engineering Materials—J. G. DiPinto

Effect of Composition on Flow Properties of Polymeric Sealants—J. Gaynor, G. W. Blum, E. G. Babolek, and C. P. Alexander

Tires

What Bladderless Curing of Tubeless Tires Can Mean in Increased Productivity—George N. Murphy

Worldwide Developments in Tire Production—C. A. Litzler

Aircraft Tire Testing Developments—H. P. Lamb

Power Wastage in Tires—G. B. Roberts

Power Loss and Operating Temperature of Tires—R. D. Stiehler, M. N. Steel, G. G. Richey, J. Mandell, and R. N. Hobbs

The Mechanical Behavior of the Tire in Dependence on Materials and Construction—W. Hofferberth

Stresses in Deflected Tires—W. F. Ames and H. G. Lauterbach

Tuesday Nov. 10

Tires

Retreading of Tires—H. Geldof

A Towing Device for Estimating Road Wear—L. P. Gelinas and E. B. Storey

An Indoor Tester for Measuring Tire Treadwear—G. G. Richey, J. Mandell, and R. D. Stiehler

Measurement of Tread Motion and Application to Tire Performance—H. H. Vickers and S. B. Robison

International Road Testing of HAF and ISAF Blacks in Passenger Tires—O. F. K. Bussemaker, E. M. Dannenberg, C. Prat, and H. Westlinning

The Role of Hysteresis in Tyre Wear and Laboratory Abrasion—A. Schallamach

A Theory of the Abrasion of Rubber—F. W. Boggs

Wednesday, Nov. 11

Advances in Test Methods

Micro-Hardness and Micro-Rebound Measurements—S. Oberto (Presented by a Colleague)

Micro-Hardness Testing—Its Possibilities and Limitations—A. L. Soden and J. R. Scott

Rubber Conference

(Continued)

New Artificial Weathering Methods—G. F. Bush

The Natural and Accelerated Ozone Aging of Elastomer Compounds—M. M. Lowman and H. P. Miller

Viscosity and Relaxation Measurements on Crude Rubbers and Compounds—S. Eccher

Aging of Rubber Vulcanizates—J. Mandell, F. L. Roth, M. N. Steel and R. D. Stiehler

The Charles Goodyear Medal Lecture

Test Methods

Standards for Rubber Compounding—F. L. Roth and R. D. Stiehler

Sulfur Group Analysis in Natural Rubber Vulcanizates—M. L. Studebaker and L. G. Nabors

The Stress-Strain Behaviour of Elastomers at Different Velocities of Deformation—G. Fromandi, R. Ecker, and W. Heideman

Classification

A Practical Method of Classifying All Elastomeric Vulcanizates—N. L. Catton, R. C. Edwards, and T. M. Loring

Statistical Methods

The Use of Regression Techniques in Elastomer Compounding—C. F. Bertsch

Modern Quality Control—S. Collier

Theory

Measurement and Interpretation of the Rate of Volume Swell and Equilibrium Volume Swell in Cross Linked Networks—D. J. Buckley and M. Berger

Longitudinal Tearing of Vulcanizates in Extension: II—Tests of Various Elastomers in a Limited Range of Temperature and Speed—R. Chasset and P. Thirion

The Measurement of Flow and Slip Velocity with the Shearing Disc Viscometer—M. Mooney

Response of an Elastomer to Any Forcing Function—M. Berger

Some Statistical Considerations Underlying Molecular Theories of Rubber Elasticity—Jacob Mazur and Turner Alfrey, Jr.

Thursday, Nov. 12

Elastomer Reinforcement

Reinforcement of Rubber by Fillers—E. Andrews, L. Mullin, and N. R. Tobin

Elastomer-Filler Interactions—J. P. Berry, P. J. Cayre, and M. Morton

Interactions of Hydrocarbons and Powders—W. C. Wake

Mechanico-Chemical Reactions Leading to Reinforcement in Rubbers—R. J. Ceresa

Oxidation of Hevea Vulcanizates Containing Carbon Black—E. M. Bevilacqua

Swell Resistance of Polymer Filler Systems to Boiling Water—S. Palinchak and W. J. Mueller

Selection of Process and Extender Oils with Minimum Staining Characteristics for Use in Rubber—J. S. Sweeley, J. B. Ziegler, R. W. King and S. S. Kurtz, Jr.

Natural Rubber and Latex

Preservation of Natural Rubber Latex in the Field—J. S. Lowe

Modern Large Scale Production of Hevea Rubber and Hevea Latex Concentrate—G. Verhaar

Recent Developments in the Production and Processing of Natural Rubber in Malaya—J. E. Morris and B. C. Sekhar

Towards the Standardization of Natural Rubber, Present Trends—M. Liponski and Vu-Dinh-Do

Physiology as a Help to Improvement of Yields of Hevea—J. LeBras

Vulcanization

Properties of Compounds Relative to Vulcanization—J. H. Gifford

Estimation of State of Cure of Elastomers by Means of Radioactive Sulfur—H. L. Pederson

Chemical Interpretation of Dicumyl Peroxide Vulcanization—L. O. Amberg and W. D. Willis

Chemistry of Vulcanization of Viton, A Fluorocarbon Elastomer—J. F. Smith

Crystallization and Cure Studies of Neoprene W Using Dielectric Measurements—M. Hanok and I. N. Cooperman

Investigation of Radical and Polar Mechanisms in Vulcanization Reactions—J. R. Shelton and E. T. McDonel

Contrasts in the Response of Elastomers to High Temperature Vulcanization—F. B. Smith

Natural Rubber and Latex, Synthetic and Natural

Recent Developments in Superior Processing Rubber—H. C. Baker

Factors Influencing the Stability of SBR Latex—F. A. Sliemers, B. Bennett, P. B. Stickney and G. Heiligmann

The Colloidal Properties of Synthetic Copolymer Latices—C. F. Fryling

Latex Masterbatching: Compounding, Development, Future Possibilities, and Influence on Rubber Manufacture—I. Drogin

Stability Testing of Natural and Synthetic Latices—J. L. M. Newnham and D. J. Simcox

A Strain Test for Latex Films and Its Application—P. R. Gyss and C. E. Wu

Polymers and Polymer Structure

Elastomeric Succinic and Anhydrosuccinic Derivatives of Natural Rubber—C. P. Pinazzi and G. Milbert

Cis-Trans Isomerization in Natural Polyisoprenes—J. I. Cunneen

Polymerization of Vinyl Monomers in Rubber Latices—P. W. Allen, C. L. M. Bell, E. G. Cockbain and R. B. Mumford

Properties of Tin Elastomers—J. C. Montermoso, T. M. Andrews, L. P. Marinelli, and B. LaLiberte

Silicone Rubber—Today and Tomorrow—P. C. Servais and K. E. Polmanteer

The Structure of Chlorosulfonated Polyethylene—A. Nersasian and D. E. Anderson

Properties of Chlorosulfonated High Density Polyethylene—P. A. Peffer, J. B. Knox, J. Kalil, and R. R. Radcliffe

Rubber Chemicals

A Study of the Behavior of Selected Derivatives of p-Phenylene Diamine in Rubber Compounds—J. T. Watts

Adhesion

Studies on the Mechanism of Adhesion in Polymeric Systems—S. B. Robison and D. J. Buckley

Some Aspects of Rubber-Textile Adhesion—G. M. Doyle

Polyurethanes

Relation of Structure to Properties in Polyurethanes—E. F. Cluff and E. K. Gladding

Reactions of Diisocyanate in Water Systems—M. E. Bailey, C. E. McGinn, and S. E. Berger

Problems Pertaining to Prepolymer Preparation—C. E. McGinn

Efficiency Through Standardization for the Army Ordnance Corps

The intense interests of the Army Ordnance Corps in standardization activities are cited in an article, "The Army Ordnance Corps and Standardization" by Major General J. H. Hinrichs, Chief of Ordnance, appearing in the October *Magazine of Standards* published by the American Standards Assn. After a brief historical review of the Ordnance Corps' standardization interests, which date back at least to Eli Whitney's idea for interchangeable rifle parts following his first musket contract in 1798, General Hinrichs describes the widespread AOC standardization effort. He notes, for example, that by VJ-Day, there were about 2000 Ordnance standards covering some 100,000 parts.

The AOC and other branches of the Army have been vitally interested in the work of ASTM for many years; General Hinrichs notes that at the present time there are AOC representatives on 37 of the main committees of ASTM. Of course, this does not include the many dozens of subcommittees and sections.

ASTM also maintains, essentially as a standby group, the ASTM Ordnance Advisory Committee, which is available to advise Army Ordnance on special problems. One of the recent activities of this group was an intensive review of a greatly revised standard covering the testing of metals, jurisdiction of which had been assigned to the AOC.

It is encouraging to see in General Hinrichs' article the statement that Army Ordnance expects to do even more in the years ahead to promote effectiveness and efficiency through standardization. He concludes with the statement that "Army Ordnance, in cooperation with industry, other services, and other free nations, is taking full advantage of this opportunity to strengthen our shield against aggression."

AFS Technical Institute Announces Expansion

The American Foundrymen's Society will erect a new building for its Training and Research Institute on the site of present Society headquarters in Des Plaines, Ill. The Institute is the first such school in North America, owned and operated by the industry, to provide foundry job training. Since early in 1957, courses have been given in 6 metropolitan foundry centers in the United States and Canada. Industry-wide acceptance of the program has pointed up the need for a permanent, well-equipped location.

In discussing the building plans, W. W. Maloney, general manager of the Society, said: "The foundry industry anticipates a 25 to 30 per cent increase in castings demand in the next 25 years. It is to meet this challenge that our field must have better trained men. The training center will help bridge the present gap between boys who enter our industry directly from high schools and vocational schools and those who come from great engineering colleges and universities."

Present courses, up to 2 weeks in length, are intended primarily for foundry "middle" supervision. Courses cover basic foundry sciences such as melting materials and methods, molding and core sands, foundry safety and environmental control, patternmaking methods and materials, materials handling techniques, and laboratory control procedures. Instructors include outstanding men from industry and educational institutions, supplementing the regular Institute staff.

Ground breaking is expected to occur late this year.

Portland Cement Association Publishes New Journal

On New Year's Day this year, the first issue of the *Journal of the Research and Development Laboratories* was published by the Portland Cement Assn. Present plans are for three issues per year. In an introductory article in the first issue, A. Allan Bates, PCA vice-president for Research and Development, and Vice-President of ASTM, described the aims of the new publication:

"The investigations of the Portland Cement Assn. Laboratories cover the complete scientific and technical range from ultimate molecular structure of silicate compounds to the massive engineering characteristics of great dams. Every possible problem concerning the nature and uses of cements and concretes interests us.... Our Journal will reflect this wide array of interests.

"We shall feel at liberty in this Journal to indulge in scientific speculation and controversy and to permit our friends and co-workers from other institutions of research and learning to do so. For this is the way of progress in the natural sciences.

"We shall present a certain quantity of original experimental results both from our own and from other laboratories in this Journal but to an even greater extent we may reconsider and re-interpret former work done anywhere in the light of recent progress.

"Upon [the] union of cement producers and consumers rests the joint responsibility for the final qualities of usefulness, reliability and durability of that most versatile and most widely used of all construction materials, portland cement concrete. To the furtherance of progress through full understanding between those partners this Journal of Research and Development is dedicated."

"The Undiscovered Earth" Theme of Conference

In a conference to be held in **Birmingham, Ala., June 11–12, 1959,** sponsored by the Southern Research Inst., attention will be drawn to the fact that our earth is still relatively unexplored. It has been said, for example, that we know less about many regions of the oceans than we know about the surface of the moon and that we know more about the interior of the sun than we do about the interior of the earth.

Many of the nation's outstanding scientists will address the conference. Topics will include:

Keynote Address—A. B. Kinzel, vice-president and director, Union Carbide Corp. Mr. Kinzel is a distinguished scientist who holds numerous patents in metallurgy and engineering.

Project Plowshare—Edward Teller, director, University of California Radiation Laboratory. This description of the vast experimental program involving underground nuclear explosions will be presented by one of America's foremost atomic scientists.

New Horizons Opened by the International Geophysical Year—Hugh Odishaw, executive director, U. S. National Committee, IGY. Implications of much of the significant information now emerging from the far-flung IGY program will be examined.

The Deep Hole Project—Gordon G. Lill, head, Geophysics Branch, Office of Naval Research. This project proposes to bore through the earth's crust below the ocean floor, and into the unknown area beneath.

Energy Sources for the Next Fifty Years—M. King Hubbert, chief consultant in general geology, Shell Development Co., an advisor to the federal government on world mineral resources.

Tapping the Earth—D. M. Davison, president, E. J. Longyear Co., specialists in drilling, mining engineering, and geophysical prospecting.

Water for an Expanding World—R. M. Leggette, consulting firm of Leggette, Brashears, and Graham. Mr. Leggette is an outstanding ground-water expert.

Thomas B. Nolan, director, U. S. Geological Survey, will discuss the nation's natural resources. Other topics: *Resources of the Oceans, Geothermal Heat*, and *Tomorrow's Metals*.

Papers to Appear in Future Issues of the ASTM BULLETIN

The Langley as a Unit for Timing Outdoor Exposures—C. H. Caryl, Desert Sunshine Exposure Tests.

Failure Mechanisms in Glass Fiber-Reinforced Plastics—M. B. Desai and F. J. McGarry, Massachusetts Institute of Technology.

Standards for Adhesives Used in Installing Ceramic Tile—J. V. Fitzgerald, H. B. Wagner, D. R. Robinson, and E. L. Kastenbein, Tile Council of America Research Center.

Mooney Cure Tests for Calculating Curing Times—A. E. Juve, The B. F. Goodrich Co.

The Interlaboratory Evaluation of Testing Methods—John Mandel and T. W. Lashof, National Bureau of Standards.

Prediction of Temperature Rise in Fire Testing of Walls and Partitions—R. H. Neisel, Johns-Manville Products Corp.

The Influence of the Direction of Loading on the Strength of Concrete Test Cubes—A. M. Neville, University of Manchester.

Low Temperature Tensile Properties of Copper and Four Copper Alloys—R. M. McClintock, D. A. Van Gundy and R. H. Kropschot, National Bureau of Standards.

Additional Studies with an All-Glass Multiple-Test Apparatus for Nitric Acid Testing of Stainless Steels—G. F. Tisinai and C. H. Samans, Standard Oil Co. (Indiana).

The Temperature Dependence of Electrical Resistivity of Laminated Thermoset Materials*

By TOM D. SCHLABACH

The temperature dependence of electrical resistivity for twelve different thermosetting laminates was studied over the temperature range of 40 to 180 C in dry nitrogen. It was found that this temperature dependence obeyed a straight-line, log resistivity *versus* reciprocal absolute temperature relationship. The apparent activation energy, E, for the thermal untrapping of current carriers was calculated using $\rho = \rho_0 e^{E/kT}$ and gave values ranging from 0.5 to 2.6 electron volts. Thermal aging of several of the laminates for one month at elevated temperature resulted in higher resistivity values and higher values of E in all but one case. These changes are attributed, in large part, to the additional crosslinking which takes place on thermal aging.

IN electrical applications involving the use of thermosetting laminates, one of the most important parameters to be considered is that of temperature. Numerous studies have been made covering the effect of elevated temperature, particularly over extended periods of time, on the mechanical and electrical properties of these materials (**1**).[1] Further, due to the work of Dakin (**4**) and others (**3**), it has been shown that the deterioration, in time, of electrical insulation caused by elevated temperature, can be treated as a chemical rate phenomenon, and this has provided the basis for a more rational temperature classification of these materials. In addition to these long-term temperature effects, however, we are also interested in the short-term effects; in this paper, an attempt has been made to determine the short-term temperature dependence of resistivity apart from any possible humidity effects.

Unlike metals, most dielectrics, including semiconductors and insulators, exhibit increased conductivity with increasing temperature. In many such cases, thermal activation of current carriers leads to an exponential relationship between conductivity, σ, and absolute temperature, T, of the general form (**18**, **19**):

$$\sigma = \sigma_o e^{-E/kT} \qquad \text{(1)}$$

where σ_0 is a constant, E the apparent activation energy for the thermal untrapping of current carriers, and k, Boltzmann's constant. This equation differs from that generally used in the organic semiconductor field (**2**, **6**, **15**); this difference is dealt with later in this paper.

Since, in practice, resistance values are actually measured, it is more convenient to use ρ, the specific resistance, and include boundary conditions on the temperature so that

$$\rho = \rho_o e^{\frac{E}{k}\left[\frac{1}{T} - \frac{1}{T_o}\right]} \qquad \text{(2)}$$

where ρ is the resistance at absolute temperature T and ρ_o the resistance at some common reference temperature T_o. Alternately, Eq 2 can be expressed as

$$\log_{10}\rho = \frac{E}{2.303k} \times \frac{1}{T} - \left(\frac{E}{2.303k} \times \frac{1}{T_o} - \log_{10}\rho_o\right) \qquad \text{(3)}$$

which is a familiar form of the equation for a straight line. Thus, if $\log_{10}\rho$ is plotted against $1/T$, a straight line should result.

Over certain temperature ranges and where the d-c field gradient is less than 1000 v per cm, Eq 1 has been found to hold for a wide variety of materials including glass, the intrinsic range for germanium and silicon (**16**), pure, crystalline organic compounds (**11**, **15**), polyethylene (**8**, **14**, **17**, **21**), pyrolyzed polymers (**24**), and physical composites such as impregnated paper (**12**, **21**) and varnished cloth (**23**).

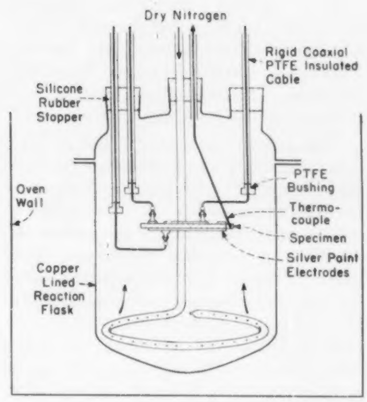

Fig. 1.—Measuring cell.

With this background in mind, resistance measurements were made on a number of laminated thermoset materials over a range of temperatures and the results treated in terms of Eq 3.

Experimental Methods

Materials

All the materials tested were thermoset laminates corresponding to the following types and grades as given in ASTM Specification D 709: XXX paper-base phenolic, XXXP paper-base phenolic (including both hot and cold punching varieties), N-1 nylon phenolic, G-5 melamine glass, G-7 silicone glass, and G-10 epoxy glass. In addition, PTFE glass (type GTE, MIL-P-19161) and mineral fiber-filled polytetrafluoroethylene (PTFE) were tested as well as a diallyl phthalate-Orlon laminate. All materials were unclad and obtained commercially in the form of $\frac{1}{16}$-in. thick sheets.

Apparatus

The measuring cell used is shown in Fig. 1. It consists of a four-neck, cop-

TOM D. SCHLABACH, member of the Technical Staff, Bell Telephone Laboratories, Murray Hill, N. J., received his Ph.D. from Michigan State University in 1952, and for the past four years has been working in chemical aspects of printed wiring including development of test methods, materials, and process evaluation.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* This paper was presented on April 14, 1958, at the Symposium on Chemical Aspects of Printed Wiring, sponsored by the American Chemical Society and held in San Francisco, Calif.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

per-foil-lined, glass reaction flask which is contained in a constant-temperature oven with air circulation. Contact to the electrodes was made using rigid, PTFE insulated coaxial cable. Continuous purging through perforated $\frac{1}{4}$-in. copper tubing was employed using tank nitrogen which had been previously bubbled through concentrated sulfuric acid and passed through a $\frac{3}{4}$-in. by 4-ft column of anhydrous calcium chloride to ensure dryness. The temperature of the specimen was measured using an iron-constantan thermocouple.

The actual resistance values were measured using an electrometer and d-c amplifier which was capable of measuring resistances to 1×10^{14} ohms with a minimum accuracy of ±8 per cent at an applied d-c potential of 9.1 v. The output of the electrometer was fed to a recording millivoltmeter across a 111-ohm resistor in parallel with the electrometer output. Since the resistance could be read directly from the electrometer, a continuous calibration of the recorder was possible. The noise level of the assembled apparatus was 1 to 5×10^{14} ohms. The oven wall, copper liner, cable shield, and electrometer had a common ground.

Test Procedure

The sheet material was cut to 3 by 3 in., and a hole was drilled in one corner to accept the thermocouple junction. Conductive silver paint electrodes were screened on using the guard ring electrode configuration where the outermost diameter was 2 in., the inner edge of the guard electrode $1\frac{3}{4}$ in., and the inner electrode $1\frac{1}{2}$ in. The electrode on the reverse side was a centered, 2-in. diameter circle. The silver paint required baking at 250 F for 2 hr. Following this, terminals were affixed using silver-loaded epoxy cement which required a 2-hr cure at 140 F. After curing, the specimens were cleaned by brushing in warm running water for 15 sec and dried with oil-free compressed air. A similar cleaning followed using reagent grade isopropyl alcohol. From this point on, the specimens were handled by their edges only. They were stored in a desiccator over anhydrous calcium chloride until ready for use.

Measurements of surface and volume resistivities were made, using a guarded electrode in all cases, by inserting the specimen in the measuring cell and allowing sufficient time for the specimen to attain thermal equilibrium. The specimen temperature during this period was followed using a recording millivoltmeter. The specimen required 5 to 20 min to attain equilibrium depending on the test temperature. The millivoltmeter was then connected across the electrometer output and the resistance continuously recorded for 45 min with zero readings taken every 15 min to check for drift. The specimen temperature was checked every $7\frac{1}{2}$ min during this period using a standard, nonrecording millivoltmeter. Separate specimens were used for each surface and volume measurement at each test temperature. Dry nitrogen, at test temperature, was pumped through the measuring cell during the entire time at a fixed rate.

Test Results

A summary of the results obtained is listed in Table I. The results have been treated in terms of Eq 3 where T_o was chosen as 296 K (23 C). The method of least squares was used to determine the values of the slope and intercept. The mean resistance, over the entire 45-min measuring interval, was used for purposes of calculation. Typical resistance changes observed during this interval

TABLE I.—TEMPERATURE DEPENDENCE OF RESISTIVITY IN TERMS OF EQ 3 WHERE T_0 = 296 K.

Material According to ASTM Specification D 709	Resistivity Measured, ρ_s (surface), ohms, and ρ_v (volume), ohm-cm	Temperature Range Over Which Equation Held, deg Cent	Slope, $\frac{E}{2.303k}$, deg Kelvin	E, electron volts	Log ρ_0	ρ_0 (surface), ohms, and (volume), ohm-cm
XXX	ρ_s	40 to 180	4 932	1.0	16.1035	1.27×10^{16}
	ρ_v	40 to 180	5 144	1.0	16.1555	1.43×10^{16}
XXXP(HP)	ρ_s	40 to 150	4 026	0.9	16.1437	1.39×10^{16}
	ρ_v	40 to 150	4 988	1.0	15.9846	9.65×10^{15}
XXXP(CP)	ρ_s	40 to 150	5 040	1.0	17.1552	1.43×10^{17}
	ρ_v	40 to 150	5 407	1.1	15.6457	4.42×10^{15}
N-1	ρ_s	40 to 150	7 824	1.6	17.8655	7.34×10^{17}
	ρ_v	40 to 150	7 942	1.6	17.3210	2.09×10^{17}
DAP-Orlon	ρ_s	60 to 180	6 633	1.3	18.0802	1.20×10^{18}
	ρ_v	60 to 180	8 852	1.8	19.1103	1.29×10^{19}
G-5	ρ_s	40 to 120	4 409	0.9	15.3862	2.43×10^{15}
	ρ_v	40 to 120	3 951	0.8	15.3754	2.37×10^{15}
G-7, 1	ρ_s	90 to 180	3 979	0.8	16.9930	9.84×10^{16}
	ρ_v	40 to 120	5 685	1.1	16.5145	3.27×10^{16}
G-7, 2	ρ_s	90 to 180[a]	2 539	0.5	17.7618	5.78×10^{17}
	ρ_v	90 to 180[a]	6 047	1.2	19.8861	7.69×10^{19}
G-10	ρ_s	40 to 150	6 676	1.3	17.3464	2.22×10^{17}
	ρ_v	40 to 150	8 072	1.6	17.4950	3.13×10^{17}
G-10 (FR)	ρ_s	90 to 150[a]	10 461	2.1	21.2412	1.74×10^{21}
	ρ_v	90 to 150[a]	12 771	2.6	21.7886	6.15×10^{21}
PTFE (mineral fiber-filled)	ρ_s	150 to 180[b]	5 693	1.2	22.0046	1.01×10^{22}
	ρ_v	150 to 180[b]	4 860	1.0	20.7243	5.30×10^{20}
PTFE glass	ρ_s	$>2 \times 10^{16}$ up to 150 C	...	...	...	...
	ρ_v	$>4 \times 10^{16}$ up to 180 C	...	...	...	...

[a] Materials tested only from 90 to 180 C.
[b] Materials tested only from 150 to 180 C.

TABLE II.—TEMPERATURE INCREMENT OVER WHICH ρ DECREASES TO $\rho/2$ AT 25 AND 90 C IN TERMS OF

$$\Delta T \text{ (deg Cent)} = \frac{0.301 T_{ref}}{\left(\frac{\text{Slope}}{T_{ref}} - 0.301\right)}$$

Material According to ASTM Specification D 709	Resistivity Measured, ρ_s (surface), ohms, and ρ_v (volume), ohm-cm	ΔT at 25 C	ΔT at 90 C
XXX	ρ_s	5.5	8.2
	ρ_v	5.3	7.9
XXXP(HP)	ρ_s	6.8	10.1
	ρ_v	5.5	8.1
XXXP(CP)	ρ_s	5.4	8.0
	ρ_v	5.0	7.5
N-1	ρ_s	3.5	5.1
	ρ_v	3.4	5.1
DAP-Orlon	ρ_s	4.1	6.1
	ρ_v	3.0	4.5
G-5	ρ_s	6.2	9.2
	ρ_v	6.9	10.3
G-7, 1	ρ_s	6.9	10.2
	ρ_v	4.8	7.1
G-7, 2	ρ_s	10.9	16.3
	ρ_v	4.5	6.7
G-10	ρ_s	4.1	6.0
	ρ_v	3.3	5.0
G-10 (FR)	ρ_s	2.6	3.8
	ρ_v	2.1	3.1
PTFE(mineral fiber-filled)	ρ_s	4.8	6.8
	ρ_v	5.6	8.3

are shown for the points plotted in Figs. 2 (*a*) to (*d*). This differs from the usual treatment in which only stabilized values are recorded but was necessitated by the permanent changes which occurred at the higher temperatures and which precluded any leveling off. The temperature range studied was 40 to 180 C except where otherwise indicated. In accordance with the convention used in the field of organic semiconductors, E has been calculated in electron volts.

To study the effect of additional thermal aging on the temperature dependence of resistivity, specimens of the XXXP paper-base phenolic (both hot and cold punching varieties), G-5 melamine glass, and G-10 epoxy glass were aged one month at elevated temperature and then rerun. The aging temperature was 150 C for the G-5 laminate and 120 C for the others. The surface and volume resistivities were then remeasured at three temperatures, 90 C, 120 C, and 150 C, except in the case of the G-10 laminate which was measured only at 90 C and 150 C. The results obtained are shown in Figs. 2 (*a*) to (*d*) where they may be compared with the initial results.

The increase in temperature, ΔT, in deg Cent, required to lower the specific resistance, ρ, from ρ to $\frac{\rho}{2}$ is given in Table II at two different reference temperatures, 25 C and 90 C. These values were determined from

$$\Delta T(\text{deg Cent}) = \frac{0.301 T_{ref}}{\left(\frac{\text{Slope}}{T_{ref}} - 0.301\right)} \quad \ldots (4)$$

where T_{ref} is given in deg Kelvin.

For purposes of comparison, the volume resistivity values as a function of temperature are shown in Figs. 3 (*a*) and (*b*).

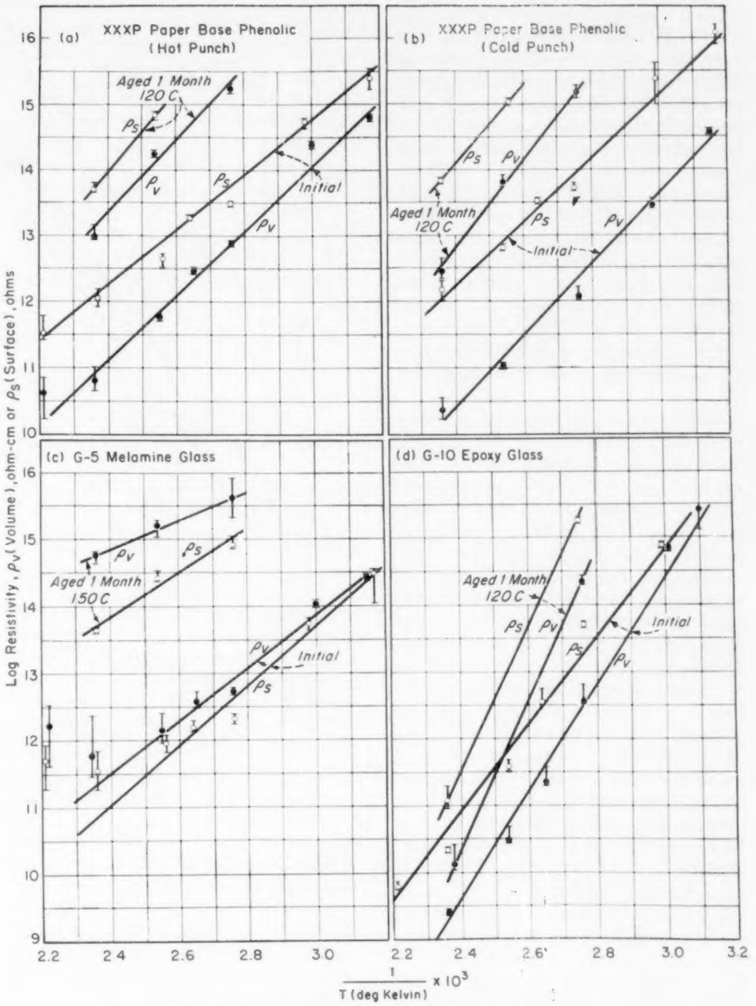

Fig. 2.—Temperature dependence of resistivity.

Discussion

As stated earlier in the paper, the temperature dependence of resistivity for these materials was treated in terms of Eq 3. The first question one asks is: how well do the data fit a straight-line, log ρ *versus* $\frac{1}{T}$, relationship? In most cases, the values fit the relationship better than might be inferred from the fact that a least squares method was used to obtain the slope and intercept. Typical fits are shown in Figs. 2 (*a*) to (*d*). Deviations were most noticeable in the range of 150 to 180 C (see Fig. 2(*c*)) which corresponds closely to the curing temperature range used to make these materials initially and wherein permanent changes were observed during the measuring interval. It is felt that the fit is sufficiently good to substantiate the use of a log ρ *versus* $\frac{1}{T}$ relationship for these materials over the temperature range studied (see Table I). In fact, the reader closely acquainted with the resistance testing of plastics (**3, 22**) may find the closeness of fit surprisingly good in the light of changes in properties attributable to the degree of cure and moisture content of these materials as received and as affected by subsequent treatment.

The value of the slope as given in the conductivity law, Eq 1, is shown equal to $-E/2.303k$, where E is the apparent activation energy for the thermal untrapping of current carriers. As noted earlier, this differs from the conductivity equation generally used in the organic semiconductor field, where the slope is shown equal to $-\Delta\epsilon/(2 \times 2.303k)$ (**2, 6, 15**) as is the case with crystalline, inorganic semiconductors like germanium and silicon (**16**). As shown by Ril' (**18, 19**) and Garrett (**9**), the equating of E to $\Delta\epsilon/2$, where $\Delta\epsilon$ is the energy gap between the top point of the valence band and the bottom point of the conduction band, involves assumptions which do not seem justified either for crystalline, organic semiconductors, or for composites of the type discussed here. Perhaps it suffices to say that the slope does include a term which gives a measure of the energy required to produce current carriers.

The values calculated for E in Table I range from 0.5 to 2.6 electron volt, and, generally speaking, the value for insulators is expected to be in the range of 1.0 to 3.5 electron volt (**20**). It is interesting to note that in all but two cases, the E values for surface resistivity are lower than the corresponding volume values. This seems reasonable since the net effect of the presence of an impurity would be to lower E, and impurities would more likely be encountered on the

surface than in the volume of the material. It must be remembered, however, that surface resistance measurements, particularly under dry conditions, probably include a large volume component more or less parallel to the laminations. Thus, the surface resistance measured is actually only an "apparent" surface resistance. Also, those materials which, as previous studies have shown, possess high insulation resistance at high humidity are observed to have high E values. Thus, diallyl phthalate-Orlon (1.3, 1.8) and N-1 nylon phenolic (1.6, 1.6) have some of the highest E values while G-5 melamine glass has one of the lowest (0.9, 0.8).

The conductivity observed within a given material, at a given temperature, humidity, and applied electric field gradient is determined by the number of current carriers, their charge, their mass, and their mobility within the material. For a given type of material under such fixed conditions we might expect some variation in the number of carriers but would expect their charge, mass, and mobility to be very similar. If this is so, then we would expect the temperature dependence of resistivity also to be very similar for a given type of material. In the case of the XXX and the two XXXP laminates, this is found to be true; In terms of E, their slopes are 1.0, 0.9, and 1.0 electron volt for the surface and 1.0, 1.0, and 1.1 electron volt for the volume. From this we might reasonably expect an E value of approximately 1.0 electron volt for other XXXP materials when measured under these same conditions of humidity and field gradient. Similarly, with the G-7 laminates the volume E values are quite close, 1.1 and 1.2 electron volts. Their surface values are in poorer agreement, 0.8 and 0.5 electron volt, for which the effect of impurities may be responsible. Of the two G-10 laminates, one is chemically different (the fire retardant type). Hence we would not expect a close match; their E values differ by a factor of about 1.5.

From this it seems that the short term temperature dependence of resistivity under these same measuring conditions might be estimated fairly well for other laminates of the same type as those studied here. Further, if we know the resistivity, ρ_1, in a dry condition, at some absolute temperature, T_1, then we can easily calculate the resistivity, ρ_2, to be expected at some other, higher absolute temperature, T_2 from

$$\log_{10} \rho_2 = \log_{10}\rho_1 - \frac{E}{2.303k}\left(\frac{1}{T_1} - \frac{1}{T_2}\right), \quad \ldots\ldots\ldots(5)$$

using the best estimate of E.

As was noted previously, the greatest

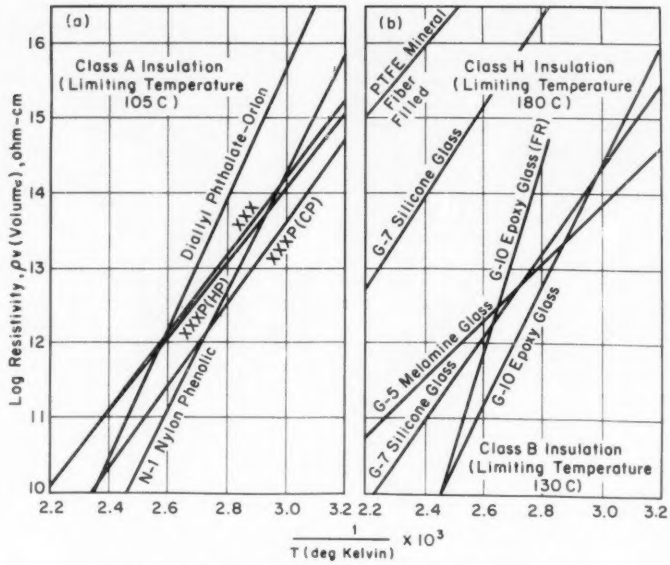

Fig. 3.—Temperature dependence of volume resistivity.

deviations from Eq 3 occurred in the range of 150 to 180 C which corresponds closely to the curing temperature range used to make these materials initially. With this in mind, samples of the two XXXP laminates, G-5 and G-10, were thermally aged for one month at elevated temperature and then rerun. The results, which are shown in Figs. 2 (*a*) to (*d*), indicate a marked change in the temperature dependence of resistivity. In terms of E, the slope changed by about 40 per cent; the change was positive in all cases except for the G-5 laminate. In addition, the actual resistance increased in all cases by about one order of magnitude at any given temperature.

Several factors could be responsible for this observed behavior, but a major cause would appear to be the additional cure which takes place on thermal aging. Further, one would favor conduction by impurity ions or protons in laminates, since they are neither conjugated systems nor presumed free of impurities as is the case with crystalline, organic semiconductors. Then, if the current carriers are impurity ions or protons, the additional crosslinking would effectively reduce the mobility of the carriers as noted by Berberich and Dakin (**3**) and might at the same time reduce their number if they were volatile or involved in the crosslinking. This picture would adequately explain the observed results but, since the nature of the current carriers in these materials has not been proved, electronic conduction cannot be ruled out. Such electronic conduction need not require a crystalline lattice (**6**, **18**, **24**) but does appear dependent on the degree of conjugation in the system (**5**, **6**, **10**, **15**, **24**). However, since the slow or rate-controlling step is the actual transfer of electrons (or holes) from molecule to molecule (**9**, **13**, **15**, **18**, **19**) it may still be that this same type of conduction can occur in laminates.

The practical significance is that aging at elevated temperatures for prolonged times can change both the temperature dependence of resistivity and the level of resistivity. The fact that the resistivity increases on aging might seem desirable from a practical point of view, but it must be remembered that excessive aging at too high a temperature could also result in a lowered resistivity through chemical degradation of the resin or reinforcement as discussed by Dakin and others (**3**, **4**). These facts indicate that the use of Eq 5 must be limited to cases where there will only be short excursions to the higher temperatures and where the best estimate of E was obtained under the same conditions. Similarly, the value of the parameter ρ_o in Eq 3 will also change markedly where significant thermal aging is involved.

Once we know the value of the slope, we can easily calculate the increase in temperature required to lower the resistivity by any fixed amount, say $\frac{1}{2}$, from Eq 4 and, since we are dealing with an exponential function, this temperature increment increases with increasing temperature. The temperature increment required to lower ρ to $\frac{\rho}{2}$ at 25 and 90 C is shown in Table II. The ΔT values range from 2.1 to 16.3 C. The average value is about 6 C. These rather small numbers emphasize the importance of considering the short term temperature effect. Actually, over

the temperature range studied, 40 to 180 C, several materials exhibited changes in resistivity amounting to seven orders of magnitude. Omission of this factor could easily lead to design failures, particularly if humidity effects were superimposed. In this study humidity effects were rigidly excluded.

Of all the materials studied, the PTFE-glass laminate gave the highest resistivity values at all test temperatures. In fact, it was so high that it exceeded the limit of our measuring equipment except in the case of surface resisitivity at 180 C. The relative resistivity values for the materials studied are shown in Figs. 3 (*a*) and (*b*). These results indicate that the two PTFE-base laminates possess the highest resistivity over the temperature range studied, followed by the G-7, 2 silicone-glass laminate. The other G-7 laminate falls in the lower range with the majority of other materials. The N-1 nylon phenolic is the lowest, as would be expected. The values of ρ_0, calculated at 23 C, follow this same trend with the exception of G-10(FR) which is comparable to the PTFE materials under these conditions. This order parallels, in general, the accepted thermal stability of these materials, though high resistivity need not necessarily be associated with good thermal stability. The added presence of humidity would undoubtedly alter this order markedly.

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Shear Effects in Glass Fiber Reinforced Plastics Laminates

By R. E. CHAMBERS and F. J. McGARRY

By simple bending tests over span-depth ratios of 7 to 70, the variation in apparent flexural modulus has been shown to result from interlaminar shear stresses set up in the specimen by the applied central load. The interlaminar shear modulus of the laminate, determined by this technique, approximates the shear rigidity of the pure resin. The true flexural modulus, measured from pure bending tests, is the average of the tensile and compressive moduli, in accordance with rational expectations. The variation of apparent flexural strength with span-depth ratio in simple bending appears to be related to the tensile ductility of the laminating resin. The magnitude of apparent flexural strength appears to depend primarily, though not exclusively, upon the strength characteristics of the resin.

In a previous paper(**1**),[1] attention was directed to the effects of cyclic loading, tensile, compressive, and flexural, on the moduli of glass fiber-reinforced plastic laminates. To observe these effects, internally positioned resistance foil strain gages were employed, making possible the observation of shifts in the neutral axis of flexural specimens as they were loaded to failure. It was pointed out that such shifts in neutral axis give rise to errors in the calculation of flexural strength values, according to the elementary expressions usually cited in test procedures. It was also recognized that the flexural moduli of laminates, as usually measured, are probably in error too, because of interlaminar shear effects ignored in simple beam theory when applied to isotropic specimens, if the specimens are adequately long compared to their thickness or depth. The purpose of the investigation described in the present paper was to study this aspect of laminate flexural behavior: the effects of interlaminar shear on the flexural modulus. In so doing, some general insight into the properties of a laminate perpendicular to its thickness would perhaps also be gained.

Under simple bending, consisting of two end supports and a single point of load application, any differential volume element of a beam is subjected to both normal or direct stress and shear stresses unless the element is located at the neutral axis, at the top surface or at the bottom surface of the beam. The normal stress acts parallel to the beam length; the shear stresses act parallel and perpendicular to the beam length, existing in equilibrated pairs or couples. According to rigorous analysis, both types of stress contribute to the total deflection of the beam, though, in practice, the effect of the shear stress is negligible for isotropic beams with a span-thickness ratio greater than 15 to 16. By conducting a series of flexure tests over a wide range of span-thickness ratios, however, it is possible to observe the influence of the shear stresses directly, which is shown by an apparent loss of beam stiffness as the ratio becomes smaller, and to calculate the shear modulus of the beam material as well as its flexural modulus (see Appendix). The accuracy with which the shear modulus can be so measured depends not only upon the level of experimental care exercised but also upon the relative magnitudes of the two moduli, as will be apparent from subsequent discussion.

Experimental Procedure and Results

The laminates, each composed of 24 plies of fiber glass fabric and Paraplex polyester resin,[2] were fabricated by the wet layup technique and press-cured under a pressure of 25 psi according to the cycle shown in Table I. Determinations of the glass content of the cured laminates, which were approximately $\frac{1}{4}$ in. thick, were made by simple ignition-loss measurements. Tension specimens, $\frac{1}{4}$ by $\frac{1}{2}$ by 8 in. long, and compression specimens, $\frac{1}{4}$ by $\frac{1}{2}$ by $1\frac{1}{2}$ in. long, were machined from each laminate, fitted with pairs of type A-7, SR-4 strain gages on opposite faces to account for stray bending effects, and tested for modulus and strength, with the average results as noted in Table II. A replication factor of three was used in these tests since the scatter in individual tests values was small.

From each laminate a group of flexure specimens was also machined. These were $\frac{1}{4}$ in. thick, $\frac{1}{2}$ in. wide, and of various lengths such that span-depth ratios from approximately 7 to 70 could be achieved. Simply supported and centrally loaded, the various specimens were tested at the same rate of outermost fiber stress increase, the central deflection being read from a dial gage while the applied load was automatically recorded. Each specimen was tested to failure, which usually took place by a buckling delamination of the compressive fibers near the loading roller, and the apparent flexural modulus, E_{BA}, and flexural strength from each test were calculated in accordance with the conventional expressions. These data are plotted in Fig. 1 in which the variations with span-depth ratio can be seen. Each point in this figure represents an average of three specimens, again with a small scatter in individual results.

The final flexure test, involving specimens $\frac{1}{4}$ in. thick, $\frac{1}{2}$ in. wide, and 13-in. span from each laminate, consisted of simple end supports and two equal

RICHARD E. CHAMBERS, who holds undergraduate and graduate degrees from MIT, is presently a research engineer in the Institute's Plastics Research Laboratory. His work is primarily concerned with the physical and mechanical behavior of reinforced plastics.

FREDERICK J. McGARRY, Assistant Professor of Materials, MIT, is engaged primarily in the study of the mechanical properties of plastics and the development of various test methods to determine such properties.

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

[2] Rohm and Haas Co., Phila., Pa.

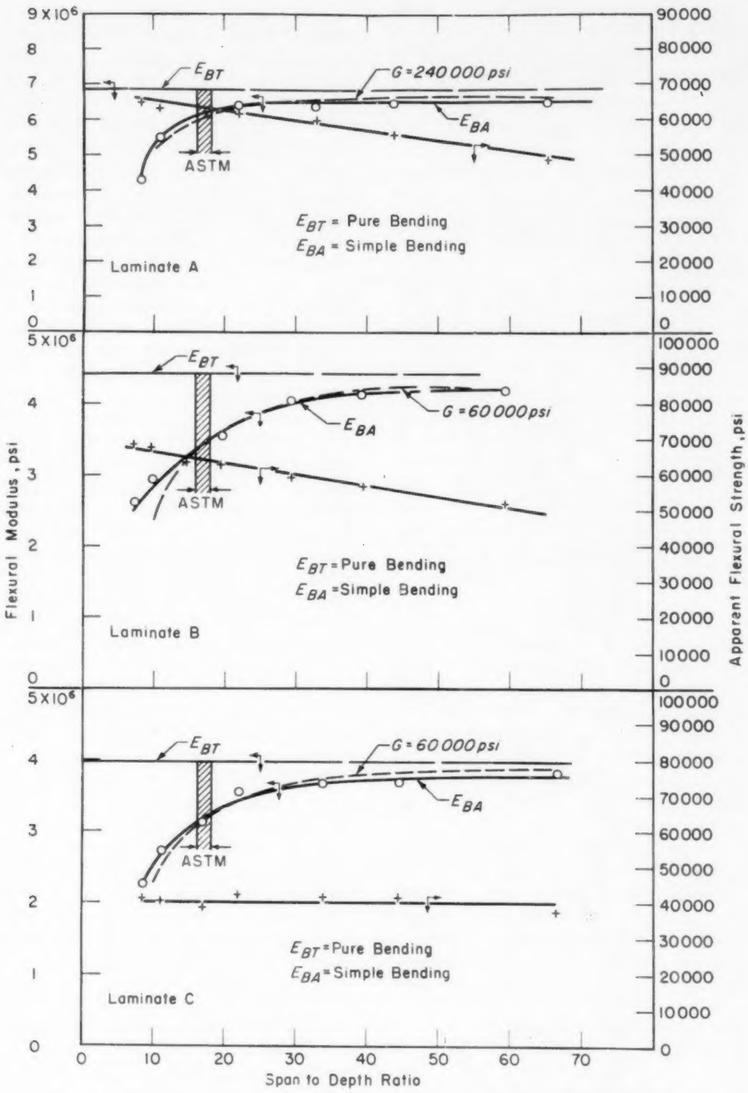

Fig. 1.—Flexural properties *versus* span-depth ratio in laminates A, B, and C.

TABLE I.—FABRICATION DETAILS OF LAMINATES.

Laminate	Fabric	Resin	Cure	Glass Content, per cent
A	143, Volan A (24 plies)	Paraplex P-43 + 0.75 per cent benzoyl peroxide	1 hr, 175 F	74
B	181, Volan A (24 plies)	Paraplex P-43 + 0.75 per cent benzoyl peroxide	½ hr, 200 F ½ hr, 220 F Molding pressure, 25 psi	70
C	181, Volan A (24 plies)	50 per cent Paraplex P-47 50 per cent Paraplex P-13 + 0.50 per cent benzoyl peroxide	Cooled under pressure	76

TABLE II.—MODULUS AND STRENGTH VALUES—UNIAXIAL TESTS.

Laminate	Modulus, psi			Strength, psi	
	Tensile (E_T)	Compressive (E_C)	Average ($E_T + E_C$)/2	Tensile	Compressive
A	6.61×10^6	6.92×10^6	6.76×10^6	99 000	59 300
B	4.26	4.41	4.33	50 500	41 400
C	3.60	4.28	3.94	49 900	28 600

loads at the quarter points, with deflections measured both centrally and at the quarter points while the loads were again automatically recorded. Under these circumstances, the central half of the specimen between the points of load application has no shear stress in it; it is undergoing so-called pure bending and its relative deflection arises solely from the action of the normal stresses present—tensile and compressive. The average modulus values, E_{BT}, from five such tests for each laminate are indicated in Fig. 1, independent of span-depth ratio and constituting asymptotes to which the simple bending modulus values approach. These pure bending tests were also carried to failure, which consisted of a compressive buckling delamination of the specimens throughout the length of the central half-span at the conventionally calculated stress values shown in Table III.

Discussion

Since pure bending involves only tension and compression, unless the tensile and compressive moduli and strengths differ greatly it would be expected that the pure bending modulus would be the average of the two uniaxial moduli. Table IV shows this to be true, within permissible limits of experimental error, and also compares the values of E_{BT} to those observed from simple bending tests in the ASTM span-depth ratio range. The latter values, as can be seen in Fig. 1, are always less than E_{BT} by the percentages shown in Table IV. This indicates that the shear stresses present in the simple flexure case have a definite effect on the observed modulus and the magnitude of this effect depends upon the particular laminate under consideration; a constant correction factor does not appear valid. It would appear that the situation warrants some study with respect to a possible review of testing procedures as applied to such laminates, however.

In theory, according to relations developed in the Appendix, it is possible to calculate the shear modulus of the flexure specimens from the curve of E_{BA} *versus* span-depth ratio. In practice, because of the very small value of this property compared to the tensile and compressive moduli, it is more realistic to determine it in another fashion: an estimate of the shear modulus value is made and used, in conjunction with E_T

TABLE III.—MODULUS AND STRENGTH VALUES—PURE BENDING TESTS.

Laminate	E_{BT}—Flexural Modulus, psi	Flexural Strength, psi
A	6.85×10^6	55 500
B	4.42	42 000
C	3.97	27 600

TABLE IV.—MODULUS COMPARISONS—PURE BENDING, UNIAXIAL, AND SIMPLE BENDING TESTS (ASTM)

Laminate	E_{BT} psi	$(E_T + E_C)/2$ psi	Difference, per cent[a]	E_{BT} *versus* ASTM Value, per cent
A	6.85×10^6	6.76×10^6	1.3	9.5
B	4.42	4.33	2.0	14.0
C	3.97	3.94	0.8	20.6

[a] Difference between E_{BT} and $E_T + E_C)/2$.

TABLE V.—COMPARISON OF PREDICTED AND CALCULATED TRUE FLEXURAL MODULI (DATA FROM REFERENCE 2).

P-43 Resin Laminates			
Fabric in Laminate	Values of E_{BT}, psi		Difference, per cent[a]
	Predicted From Eq 1	Averaged From Eq 2	
112	2.73×10^6	2.75×10^6	−0.7
116	3.03	3.39	−10.6
128	3.40	3.64	−6.6
162	2.81	2.99	−6.0
143	5.27	5.43	−3.0
120	2.81	3.01	−6.6
181	2.98	3.12	−4.5
182	2.95	3.18	−7.2
184	3.05	3.42	−10.8
M503	2.10	2.14	−1.9
128	3.23	3.28	−1.7

[a] $\left(\frac{\text{Predicted} - \text{Averaged}}{\text{Averaged}}\right)$

TABLE VI.—MEASURED MODULUS VALUES (FROM REFERENCE 2)

Fabric in Laminate	E_{BA}, psi[a]	E_T, psi	E_C, psi
112	2.59×10^6	2.69×10^6	2.82×10^6
116	2.86	3.57	3.20
128	3.18	3.59	3.69
162	2.66	3.16	2.81
143	4.75	5.69	5.18
120	2.66	3.06	2.96
181	2.81	2.95	3.30
182	2.79	3.21	3.14
184	2.87	3.51	3.33
M503	2.02	1.99	2.29
128	3.03	3.10	3.47

[a] E_{BA}—Measured bending modulus, single central load, end supports. E_T—Tensile modulus, uniaxial test. E_C—Compressive modulus, uniaxial test.

and E_C to calculate E_{BA} as a function of the span-depth ratio. The resultant curve is then compared to the observed variation. Thus:

$$1/E_{BT} = 1/E_{BA} - 6/5\,(d/l)^2\,1/G \quad \ldots (1)$$

where:

$$E_{BT} = E_T + E_C/2 \quad \ldots (2)$$

and,

d = specimen thickness, while l = specimen length.

In Fig. 1 the curves marked with a value of G show the best over-all fit for this approximation which could be found for each laminate; where the type 143-fabric has comparatively few cross yarns, the shear modulus so determined is 240,000 psi; with the balanced type 181-fabric the values are both 60,000 psi. The shear modulus of the unreinforced resin, by measurement, is approximately 230,000 psi for laminates A and B and 40,000 psi for laminate C, the latter value being an estimate. This permits the qualitative observation that the interlaminar shear rigidity of these laminates is essentially that of the resin, though a fabric-resin interaction, in some way related to the weave of the fabric, may affect the modulus to a measurable degree. Thus, to a first approximation, the stiffness of a laminate perpendicular to its thickness depends upon the stiffness of the resin component. This observation, while perhaps not unexpected, should be genuinely helpful in developing more accurate engineering analyses of laminate behavior for design purposes.

To further explore the validity of Eqs 1 and 2 a more voluminous compilation of modulus data by Fred Werren (**2**) was examined. The true flexural modulus, E_{BT}, was calculated by Eq 1, assuming $G = 230{,}000$ psi, the shear modulus of the pure resin used in his laminates. This was then compared to the value of E_{BT} found by the simple averaging of the tensile and compressive moduli which he measured. The comparison of the two values of E_{BT}, predicted or calculated, and averaged from uniaxial tests, is given in Table V. (The observed moduli from which these calculations were made are presented in Table VI.) Under the circumstances of this comparison, the correlation between predicted and averaged values in Table V is reasonably good in most cases. It is interesting to point out that the negative sign of the per cent difference factor indicates that the assumed value of 230,000 psi for the interlaminar shear modulus of the laminates is too large; conversely, too small an assumed modulus value results in a positive sign for this factor. Thus, as in our work also, some fabric-resin interactions occurred with these laminates.

Perhaps most difficult to understand in this investigation is the variation of apparent flexural strength with span-depth ratio. Earlier work (**1**) has demonstrated that the tensile modulus decreases with increasing tensile stress, due to internal fiber-resin failures caused by the lack of tensile ductility on the part of the resin. This is responsible for a finite shift in the position of the neutral axis as the test progresses. Also, unless the tensile and compressive moduli remain equal throughout the test, the simple calculation of flexural stress at failure is doubly incorrect since it assumes that the neutral axis starts and remains fixed at the centerline of the specimen and a linear strain distribution through the specimen thickness always obtains. Both of these factors contribute to error in the flexural stress calculation but in a fashion which remains elusive. That the resin properties may be controlling in the situation is suggested by the fact that the ordinates and slopes of the apparent flexural strength *versus* span-depth ratio curves for the P-43 laminates, A and B, are nearly identical, while the ordinates and slope of the weaker, less stiff P-47:-P-13 blend, laminate C, are much less and may indeed be independent of the ratio. Recent unpublished work with the latter blended resin leads us to believe that its much greater tensile ductility eliminates the internal failures under tensile stresses mentioned previously. This may tend to prevent a progressive decrease in the tensile modulus caused by such failures and inhibit the neutral axis shift observed with the less ductile P-43 resin laminates. Whether or not such an action actually is responsible for the fairly constant value of the flexural strength of laminate C specimens must remain conjectural until further study is carried out.

One final observation with respect to flexural strength appears justified: in most cases the failures of the specimens were by means of compressive buckling and delamination. From Tables II and III it is interesting to note that the uniaxial compressive strengths are strikingly similar to the flexural strengths calculated from the pure bending tests. This may further illustrate the desirability of the latter method of determining laminate flexural properties, though much more data would be necessary to establish such a conclusion above doubt.

Conclusions

On the basis of the foregoing, the following conclusions appear valid:

1. The interlaminar shear rigidity of a fiber glass-polyester laminate depends primarily upon the shear modulus of the laminating resin.
2. The comparatively low shear modulus of the resin strongly affects the apparent flexural modulus of laminate specimens.
3. The flexural modulus of a laminate, when the shear effect is eliminated, is merely the average of its tensile and compressive moduli determined from uniaxial tests, unless the latter differ greatly in magnitudes.
4. The ASTM recommendations for span-depth ratio in laminate flexure testing result in erroneous modulus values. The magnitude of the error is

not independent of laminate characteristics.

5. Serious consideration should be given to the possibility of using pure bending tests to measure the flexural properties of fiber glass-resin laminates.

Acknowledgment

This work was performed in the M.I.T. Plastics Research Laboratory, A. G. H. Dietz, Director, which is supported by a Grant-in-Aid from the Manufacturing Chemists' Assn., Inc. The reinforced plastics research program has been supported by funds received from the National Science Foundation, Owens-Corning Fiberglas Corp., Shell Chemical Corp., and Pittsburgh Plate Glass Co.

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APPENDIX

The formula derived by Timoshenko[3] for the end deflection of a cantilever, fixed at one end and subjected to a concentrated load at the other, may be modified to provide the equation for the deflection of a simply supported beam, loaded at midspan. This deflection equation may be written as follows:

$$\delta = \frac{Pl^3}{48EI}\left[1 + \frac{6}{5}\frac{d^2}{l^2}\frac{E}{G}\right] \quad (3)$$

where:

δ = central deflection,
P = central load,
E = modulus of elasticity of the material,
I = moment of inertia of cross-section about the neutral axis,
d = depth of beam,
l = length of beam between supports, and
G = shear modulus of the beam.

Equation 3 specifically includes the effects of shear, thus the modulus, E, is the true bending modulus E_{BT}. In a simple flexure test in which the effects of shear are neglected, the usual relation expressing the action of the beam is given by:

$$\delta = \frac{Pl^3}{48EI} \quad (4)$$

where the modulus, E, in Eq. 4 is the apparent bending modulus, E_{BA}, the value of which is influenced by the span-depth ratio of the beam. Now equating Eqs. 3 and 4 and recognizing the differences in E_{BA} and E_{BT}:

$$\left(\frac{Pl^3}{48I}\right)\frac{1}{F_{BA}} = \left(\frac{Pl^3}{48I}\right)\frac{1}{E_{BT}} \times \left[1 + \frac{6}{5}\frac{d^2}{l^2}\frac{E_{BT}}{G}\right] \quad (5)$$

or:

$$\frac{1}{E_{BT}} = \frac{1}{E_{BA}} - \frac{6}{5}\left(\frac{d^2}{l^2}\right)\frac{1}{G} \quad (6)$$

Because E_{BT} and E_{BA} are much larger than G, small variations in their values produce large changes in the calculated value of G. For this reason it is much more valid to choose a reasonable value for G and, knowing the measured value of E_{BT}, calculate the variation of E_{BA} as a function of length. The curve thus calculated can be compared to the experimentally determined variation of E_{BA} *versus* length. The value of G giving the best over-all fit of the two curves is then judged to be the best approximation of the beam shear modulus.

[3] S. Timoshenko, "Strength of Materials," Part I, Third Ed., D. Van Nostrand Co., Inc., New York, p. 319 (1955). We are indebted to C. B. Norris, Forest Products Laboratory, for calling this particular form of the equation to our attention.

Technical Note

A Rapid Scanning System for Recording Thermocouple Outputs

A simple method of recording transient temperatures in solids is to connect individual temperature sensors spaced within the solid to individual channels of a multichannel recording oscillograph. Disadvantages in such a system arise from the limited frequency response of the recording galvanometers and from the fact that an individual record is obtained for each measurement point. This latter is a disadvantage since considerable data processing is necessary before the temperature distributions in the solid can be reconstructed. In an ideal system, frequency response is high, and the data are presented in a form showing clearly

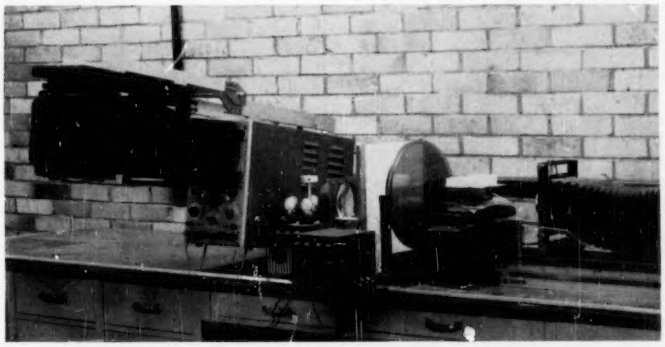

Fig. 1.—Measuring and recording equipment.

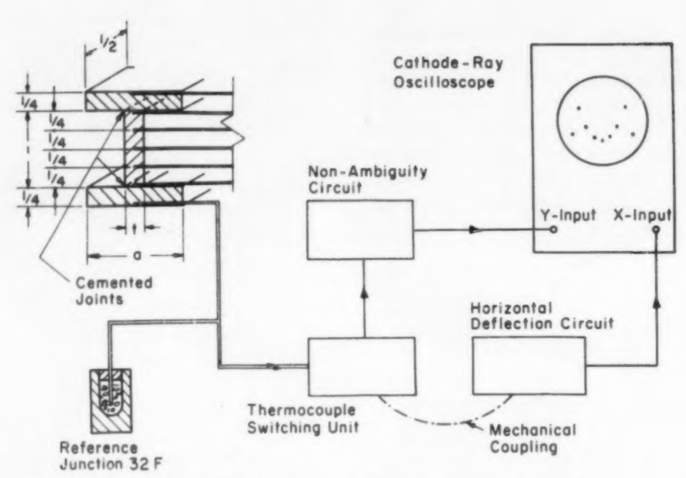

Fig. 2.—Schematic diagram of temperature measuring instrumentation.

the spatial distributions of temperature.

This note describes a high-frequency-response system in which all the data appear as an array of dots on a single 5 by 7-in. sheet of film. Thermocouples used as temperature sensors are connected to a switching unit which presents their voltages serially to a high-gain cathode-ray oscilloscope. A permanent record is made by photographing the face of the cathode-ray tube.

The main features of the recording device are summarized as follows:

1. The system is relatively easy to build and can be adapted to conventional cathode-ray oscilloscopes with sufficiently high d-c gain. For a low d-c gain instrument, an additional preamplifier may be required. Recording is by a simple open-shutter camera.

2. The thermocouple outputs appear on the screen of the cathode-ray oscilloscope as a dot array. Each dot is the output of a single thermocouple at a particular time. The vertical distance of each dot from a reference position indicates the temperature, while the horizontal spacing may be made to represent the actual spatial location of the thermocouple in the model.

3. A permanent record of the temperature distribution is made by photographing the dot array for each scan of the model. By the use of a nonambiguity circuit incorporated in the unit a number of scans, each clearly separated from its predecessor, may be recorded on a single photographic plate.

The unit was successfully used to record the transient temperature field in plastic photoelastic models of aircraft wing sections that were subjected to thermal shock with dry ice at the surfaces. Figure 1 is a photograph of the measuring and recording equipment for both stress and temperature. The temperature recording system is shown on the left. A schematic diagram of this system is shown in Fig. 2.

Temperatures in the model were sensed by seven copper-constantan thermocouples connected by a switching unit to the vertical-deflection circuit of a type 324 Dumont high-gain cathode-ray oscilloscope. The electron beam is moved stepwise in the horizontal direction by a conventional voltage-divider network. The horizontal and vertical circuits are synchronized mechanically and the result is a series of dots on the oscilloscope. Figure 3 shows a recording of model temperatures at four different times. Each thermocouple has its own reference junction in an ice-water bath at 32 F and is connected to the switching unit in such a way that large loops are avoided. The circuits comprising the scanning system are described below.

Vertical Deflection Circuit

The electron beam is deflected in the vertical direction by the voltages generated in the thermocouples, as shown schematically in Fig. 4. Seven thermocouples sense the model temperature, one places a reference-temperature dot on the oscilloscope screen, and one is used to calibrate the instrument. All thermocouples are connected to a switch that presents them in succession through a nonambiguity circuit to the Y-input of the oscilloscope. The time required to switch manually through one cycle was estimated to be 250 millisec. For more rapid scanning, a power-driven switch or beam switching tubes could be used.

Nonambiguity Circuit

A voltage-divider network produces small constant-voltage potentials that are superimposed upon the generated voltages of the thermocouples. The effect is to displace the electron beam in a vertical direction by a selected small distance for each cycle of temperature measurements. With this arrangement, several sets of temperature readings can be recorded on a single photographic plate without superimposing points. The resulting data are clear and unambiguous.

A rotary switch in the nonambiguity circuit is advanced manually one position between successive scans. This displaces the electron beam up or

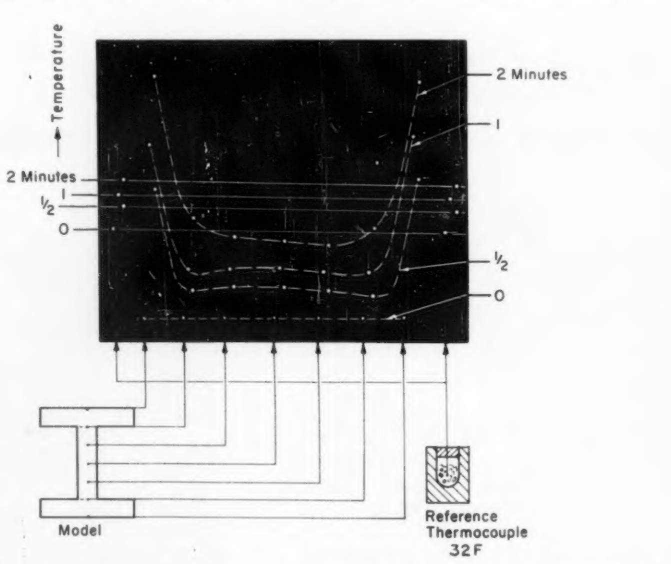

Fig. 3.—Typical temperature recording. The solid and dashed lines on the record have been added to show the temperature profiles.

Further Development and Use of the Armstrong Sandpaper Abrasion Machine

BY F. M. GAVAN

The Armstrong abrader has been in continuous use since 1941 for evaluating the sandpaper-abrasion resistance of smooth-surface resilient floor coverings. During that time the design of the machine has been modified without changing essential characteristics. The machine is now available commercially. Various operating techniques have been devised. Comparisons with certain other machines are shown. A half-size model is described.

Model 1 Machine

THE ESSENTIALS of the problem of assessing the abrasion resistance of floor-covering materials, and the development of the Armstrong sandpaper abrasion machine were described in a paper (**1**)[1] appearing in the ASTM BULLETIN of December 1946. That machine, designated model 1, has been in use at the Armstrong Cork Co. since 1941 for evaluating the abrasion resistance of experimental floor-covering materials. The machine consists essentially of a 2-in. wide tape of abrasive traveling at 20 in. per min and mounted on a movable carriage held in contact with the specimen by dead weights acting through pulleys. The specimen, $1\frac{3}{4}$ by $4\frac{1}{2}$ in., is cemented to an aluminum carrier plate, and moves at 80 in. per min. Each specimen comes in contact with sandpaper moving in the opposite direction at a differential speed of 100 in. per min, and is abraded once approximately every 36 sec. Abrasion resistance is evaluated by observing the surface of the specimen but more exactly by measuring the loss of weight during the abrasion cycle. The abrasive action is in continuous calibration by means of a standard zinc plate abraded at the same time. The usual run, using a standard contact force of 30 lb, is considered to be complete when the zinc plate has shown a weight loss of 0.50 to 0.55 g. One zinc plate and 7 abrasion specimens constitute a load for one run on the machine.

Shortly after publication of the description of the first Armstrong machine, a similar machine was constructed in the laboratories of the American Cyanamid Co. at Stamford, Conn. This has given reliable results, using slightly different techniques, in the evaluation of resin-impregnated laminates and other hard-surface finishes (**2**) (Fig. 1). An additional machine was constructed for Armstrong in 1948 by the Rue Manufacturing Co. of Philadelphia.

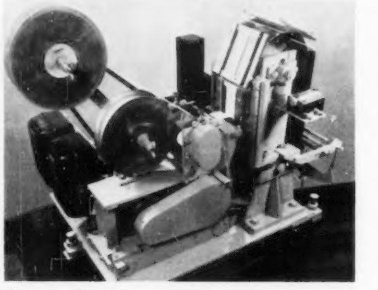

Fig. 1.—Abrasion machine built by American Cyanamid Co., Stamford, Conn. Modeled on Armstrong model No. 1. (Cyanamid Photo).

Model 2 Machine

In the model 2 machine, built in 1948, certain essential characteristics of the apparatus were unchanged:

(1) the speed of the sandpaper, (2) the speed of the specimen carrier belt, (3) the number of specimens, (4) the area of the specimens, and (5) the size of the machine. At the same time it was decided not to make any changes in the type and dimensions of the abrasive tape, in the method of controlling the tension on the sandpaper, and in the dead weight system which controls the contact force between the specimen and the sandpaper. Operation was improved, however, by adding ball bearings where applicable, an improved arrangement of the sandpaper take-up roll, a clutch for disengaging the specimen carrier belt when adjusting the machine, positive drive for the sandpaper roll, and a system of rollers (Fig. 2) for supporting the specimen mounting plate as it passes in contact with the sandpaper. Model 2 was calibrated against model 1, and has since afforded reliable results with both machines being used interchangeably.

Model 3 Machine

In 1952, the Custom Scientific Instruments Co. was consulted concerning a model 3 design and the construction of five machines for the Armstrong Cork Co. In the model 3 design (Fig. 3) the essential characteristics were held constant but some refinements were added: (1) a new method of fastening the specimen to the machine, (2) a stronger frame which makes realignment

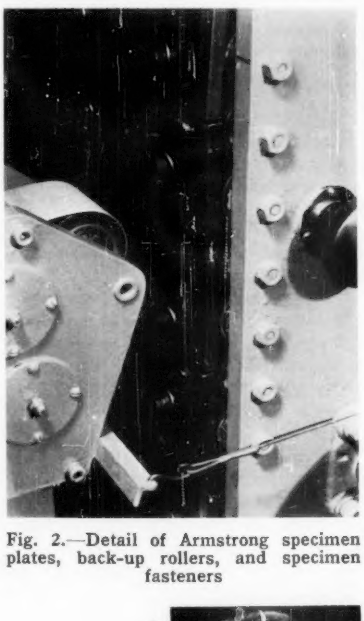

Fig. 2.—Detail of Armstrong specimen plates, back-up rollers, and specimen fasteners

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

FRANK M. GAVAN, manager of the Physical Testing Department of the Armstrong Research and Development Center, Lancaster, Pa., received his A.B. in Physics from Dartmouth College in 1931. His professional interests include testing and standardization in the fields of thermal insulation, resilient floorings, adhesives, gaskets, plastics, and other non-metallic materials. Active in ASTM committees D-11, C-16, and E-1, he is present chairman of E-1 Subcommittee 14 on Conditioning and Weathering and Subcommittee 27 on Low Temperature Tests of Elastomers.

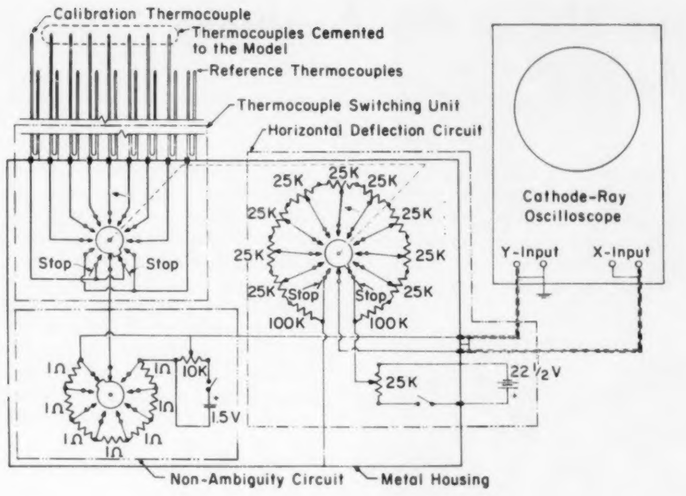

Fig. 4.—Schematic circuit diagram.

down on the screen, the deflection direction being chosen to coincide with that produced by the thermocouples. Figure 3 shows four sets of temperature readings on a single film with each set displaced by the non-ambiguity circuit from the preceding set. The effect of this circuit is clearly noticeable in the displacement of the reference dots.

Horizontal Deflection Circuit

This circuit deflects the cathode-ray beam stepwise in the X-direction. Each rest position of the beam is associated with a particular thermocouple location in the model. The result on the oscilloscope screen, is a two-dimensional plot of points of temperature *versus* locations.

The schematic diagram of the voltage-divider network is shown in Fig. 4. Provision in the first and last steps and between rest positions is made to drive the cathode-ray beam off screen. This is necessary in the open-shutter photographic technique used for recording. The potentiometers in the network are used to position the rest points of the beam in the horizontal direction to simulate the relative positions of the thermocouples in the model. The switch of the horizontal deflection circuit is mechanically coupled to the thermocouple switching and both are operated manually by a crank attached to their common shaft.

Test Procedure

The drift in the vertical direction of the oscilloscope set for high gain requires calibration checks and adjustments before each test. The calibration thermocouple and a standard thermometer are held at a common temperature which is gradually changed over the whole test range. The displacement on the oscilloscope screen from the 32 F reference mark is plotted against the temperature indicated by the thermometer. This calibration curve is then later used to evaluate the recorded temperature data.

The necessity of frequent recalibrations can be avoided if two reference thermocouples are used instead of one. If each thermocouple is at a different constant temperature, their relative dot displacement on the cathode ray tube would continuously check the validity of the calibration curve and indicate any changes in the sensitivity of the instrument.

Experimental Accuracy

The accuracy of the temperature measurements is limited by the sensing accuracy of the thermocouples inside the model, the accuracy of the calibration curve, and the error made in reducing the test data.

An error will result if the thermocouple junction is not at the same temperature as the model. It was estimated that this error could be kept within ±1 F by the following:

1. Keeping the bead of the welded junction as small in diameter as the thermocouple wires.
2. Embedding the thermocouples deep in the plastic model using the polymerized monomer of the plastic as cement. This is the equivalent of welding the thermocouples deep in the model.
3. Insulating the thermocouple wires to prevent appreciable heat flow from the outside along the wires to the junction.

An error of ±1 F must be expected in checking the accuracy of the calibration curve by known temperatures: boiling water, ice-water bath, melting mercury, and sublimating dry ice. The additional error in data reduction and location of the thermocouples is estimated to be within ±1 F. The total error is then ±3 F.

Conclusions

The scanning and recording system described in this report has general application to transducer devices in which the output is an electrical voltage. In this category would be those employing Wheatstone bridges, piezoelectric crystals, and others. The outputs of strain gages, accelerometers, pressure transducers, and velocity meters could be successfully recorded. It should be a comparatively simple procedure to develop suitable calibration schemes for each of the transducers similar to the scheme described here for thermocouples.

Herbert Tramposch
Ralph Papirno
George Gerard
College of Engineering
New York University

of the machine easier, (3) a silent sandpaper drive, (4) an improved clutch, (5) an improved sandpaper take-up mechanism, (6) improved ways in the base to reduce the rolling friction of the sandpaper carriage, and (7) various small parts of better design. The five model 3 machines were calibrated against models 1 and 2 and placed in operation in various plants of the Armstrong Cork Co. They are now being used interchangeably with machines 1 and 2 (Table I).

Sandpaper and Zinc Supply

Since 1946 the flint paper has been furnished by the Behr-Manning Co. who have made every effort to manufacture it in a controlled and uniform fashion so that the variation between the 2-in. wide, 50-yd rolls will be held to a minimum. Each order for flint paper for use on the Armstrong abrader is made into one master "Jumbo" roll, 36 in. wide. The 50-yd rolls of 2-in. wide tape cut from this master roll are lettered longitudinally and numbered transversely so that their former position in the large roll may be determined exactly. Each package received in the Armstrong laboratories from this order then contains a single cut of rolls marked, say, A_1 to A_N cut from adjacent locations across the roll. After at least one month of conditioning in an atmosphere of 70 F and 50 per cent relative humidity, two rolls selected at random from each of several representative packages are tested against zinc plates of known characteristics. These are plates which have been previously run against calibrated sandpaper from an older shipment. The average characteristics of the flint paper are thus measured to determine the proper abrasion cycle length. This method of control, employing a chain linkage between old zinc and old sandpaper and new zinc and new sandpaper has assured that small variations in the flint paper will not be compounded to produce large variations in the results obtained.

Although the use of Behr-Manning O-E flint paper has been standard for these machines, other papers have been studied to determine alternate sources for abrasive papers of the same or different characteristics. It is emphasized that any abrasive used must be controlled in a manner similar to that described above.

The zinc standard, procured from the New Jersey Zinc Co., is manufactured to rigid specifications as mix No. 103 in one approved thickness with a scleroscope hardness of 15.5. New plates are broken in by subjecting them to one full run (60 cycles) on the abrasion machine which removes the skin, and then comparing them with old plates of known characteristics using calibrated flint paper.

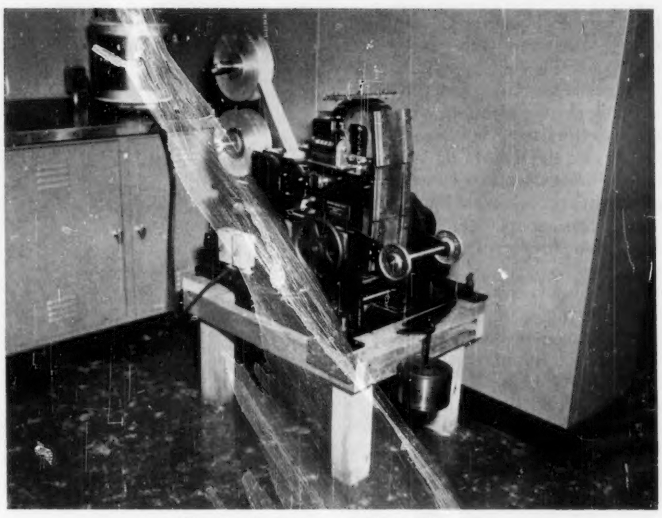

Fig. 3.—Armstrong model 3 abrader.

Operating Details

Sandpaper tension is controlled by using a torque wrench to adjust the pressure on the sandpaper drive rolls. Assurance that this tension is correct and that the relative slippage of the sandpaper and the specimen is unchanged is obtained by measuring the total length of the sandpaper used in the standard test of approximately 60 revolutions of the specimen carrier belt. If this varies by as much as 10 in. from the control the tension on the paper must be adjusted to bring it into line. An inspection of this sort is made once every month, or more often, depending on usage.

The alignment of the machine is also very important; methods have been devised for bringing the machine into alignment quickly, and for checking alignment and uniformity of contact by means of a pencil carbon paper impression. The impressions so obtained are dated and filed and compared with subsequent checks which are made whenever mechanical adjustments or nonuniform abrasion indicate misalignment.

The assurance that all Armstrong abrasion machines may be used interchangeably has been accomplished by the development of a method of calibration using standard zinc plates and standard flint paper. However, since the zinc plates are relatively expensive, plexiglas has been used as a secondary standard for comparison purposes as shown in Table I.

Results Obtained

The author (1) and others have stated that the use of abrasion machines should be confined to the evaluation of experimental materials in the laboratory. All efforts to predict service life of a material from such laboratory evaluations must be reviewed carefully. This is particularly true for smooth-surface resilient floor coverings whose wear in service is affected by the combination of a number of indeterminate factors. Just a few of these factors which must be kept in mind are the standards of the consumer, the pattern and general appearance of the flooring, the degree of dirt retention,

TABLE I.—COMPARISON OF SEVEN ARMSTRONG ABRADERS USING PLEXIGLAS SPECIMENS CUT FROM ONE 36 BY 36 BY ⅛-IN. SHEET.[a]

Abrader[b]	Plexiglas Loss,[c] g							Zinc Loss,[c] g		
	Actual						Average	Actual		Average
1	0.43	0.44	0.44	0.45	0.45	0.45	0.443	0.54	0.53	0.535
2	0.43	0.43	0.43	0.45	0.45	0.45	0.440	0.53	0.53	0.530
3	0.43	0.43	0.44	0.44	0.44	0.46	0.440	0.53	0.53	0.530
4	0.42	0.42	0.43	0.43	0.44	0.44	0.430	0.52	0.53	0.525
5	0.42	0.43	0.44	0.44	0.44	0.44	0.435	0.53	0.54	0.535
6	0.42	0.43	0.43	0.43	0.44	0.44	0.432	0.52	0.54	0.530
7	0.42	0.43	0.43	0.43	0.43	0.44	0.430	0.52	0.54	0.530

[a] Tests made July 11, 1952.
[b] Numbers 1 and 2 are models 1 and 2, Nos. 3 through 7 are model 3.
[c] One run on each machine using 6 Plexiglas specimens, 2 zinc plates, 30 lb contact force, 64 cycles at 70 F and 50 per cent relative humidity.